AUSTRALIAN
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ENGINEERING

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AUGUST 1996

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SHARC, the world's fastest floating-point 32 Bit DSP, fully supported by I.C.D.

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Revolution by stealth

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Top 100 Electronics Companies in Australia

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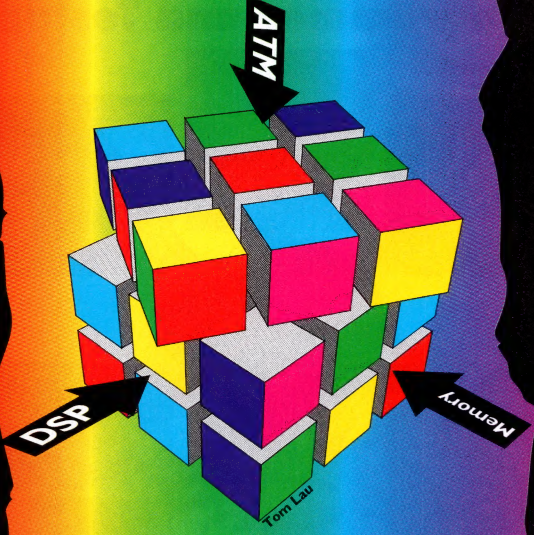

This month:

Reconfigurable logic is changing the way electronics designers think about the division between hardware and software.

See page 40.

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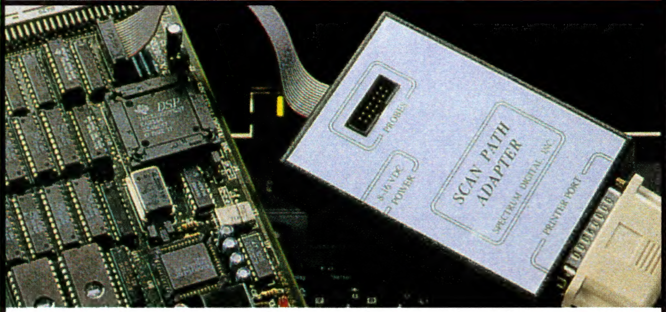

Scan Path Emulator for the TMS320C5X DSP

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- Uses JTAG scan path interface.
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FROM THE EDITOR'S DESK

Revenue and relocation

In this issue of *AEE* we present a special supplement with the results of our **Top 100 Electronics Companies in Australia** survey. It certainly makes fascinating reading and I'd like to pass on a big thanks from the *AEE* staff to all those companies who helped us by filling in the survey forms.

Gathering the information for the feature was a huge job and was interesting from several points of view. One thing that surprised me, though perhaps it shouldn't have, was the attitudes of different sectors of the industry to supplying financial information.

While no company wants to give any advantage to its competitors, and knowing the financial status of your opposition can be an advantage, it is interesting to note that the reluctance for disclosing even a number like gross sales revenue seemed to be dependent on the sector of the industry a company was involved in.

For example, we found it easier to get financial information from companies involved in telecommunications than those in component or equipment sales and distribution. My conclusion was that this was a reflection of the relative competitiveness and state of bouyancy of these sectors. Telecommunications is seeing boom times in Australia while the distribution industry is having to compete hard to increase the bottom line.

Perhaps this observation could be put to good use by financial and business analysts. To judge the state of an industry, simply ask a few companies what their annual sales revenue is. If they all toss you out the door, then the industry is probably pretty tight.

All in all though, it's an impressive array of quality companies representing an annual turnover of more than $8 billion. It's yet another demonstration of the large part the electonics industry plays in the Australian economy.

On another topic, next month *AEE* will present a preview of Elenex 96 to be held in Melbourne in early October. If you're planning to visit the exhibition, make sure you drop in at our stand for a chat. I can't promise tea and cakes, but the *AEE* team will be there to discuss the magazine and the electronics industry in general, and of course to have a bit of a gossip.

One final note — *AEE* is moving. We're leaving our sunny offices in the Sydney suburb of Chippendale (to the distress of the local publican) for the bright lights of Chatswood. As of August 24, the contact details for *AEE* will be: **Level 9, Chatswood Plaza, 1-5 Railway Street, Chatswood NSW 2068,** tel **(02) 9372 5222**, fax **(02) 9934 7377**.

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47 Chippen St, Chippendale, NSW 2008
PO Box 815, Strawberry Hills, NSW 2012
Tel: (02) 699 2411
Fax: (02) 698 3920, 319 4487

Editor
Rob Irwin
Journalist/Assistant Editor
Justine Gcake
Asian News Source
EDN Asia
Electronic Business Asia
NSW Sales Manager
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Debbie Pine
Circulation/Subcription enquiries
call customer service on:
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Victoria PO Box 82, Port Melbourne, 3207 Tel: (03) 9245 7373 Fax: (03) 9245 7511 **South Australia** 18 Dequetteville Terrace, Kent Town 5067. Tel: (08) 363 4262 Fax: (08) 363 4259 **Queensland** Ground Floor, Oxley House, 25 Donkin St, West End 4101. Tel: (07) 3846 5333 Fax: (07) 3844 0900 **Western Australia** Suite 3, 70 Churchill Avenue, Subiaco, 6008, Tel: (09) 388 7667, Fax: (09) 388 7668 **New Zealand** Mike Bridgman, Bridgman Marketing & Media Ltd, PO Box 991, Auckland. Level 8, 17 Albert Street, Auckland. Tel: (9) 308 9693 or (9) 358 0680 Fax: (9) 358 0570 **United Kingdom** Anthony Turner, The Colin Turner Group, City Cloisters, 188-196 Old Street, London EC1V 9BX, UK. Tel: (71) 490 5551 Fax: (71) 490 2271 **Germany** Mr Friedrich Anacker, InterMedia Partners GmbH, Deutscher Ring 40, 5600 Wuppertal 11 Germany. Tel: (202) 71 1091 Fax: (202) 71 2431 **USA** Roy Diton, Trade Media International Corporation, 1328 Broadway, New York, NY 10001 USA. Tel: (212) 564 3380 Fax: (212) 594 3841 **Hong Kong** Mr C K Kwok, Eastern Source International Media Centre, 4/F., Professional Building, 19-23 Tung Lo Wan Road, Causeway Bay, Hong Kong. Tel: (852) 890 5510 Fax: (852) 895 1443 **Singapore** Associate Media, Blk. 152 Bukit Batok St. 11, #01-258, Singapore 2365, Tel: 65 563 6756/563 6757, Fax: 65 563 6523 **Taiwan** Mr Polo Chang, Business News, PO Box 3-178, Yungho, Taiwan, ROC 23498. Tel: (2) 736 0027 Fax: (2) 738 4822 **Canada** Mr Ed Bush, International Advertising Consultants Ltd, 2 Carlton Street, Suite 1301, Toronto Ont. M5B IJ3. Tel: (416) 977 6269 Fax: (416) 977 6276 **Korea** Mr O-Kyu Park, World Marketing Inc, Dongbo Bldg, 81-9 Nomhyun-Dong, Kangnam-Ku, Seoul, 135-010 Korea. Tel: (822) 511 4944 Fax: (822) 548 8295 **Italy** Mr. Orlando Langs, Organizzazione Pubblicita Qotidiani S.R.L., Via Turanti 29 20121, Milano, Italy Tel: 39 2 655 2672, Fax: 39 2 655 2864 **Sweden** Mr Jacques Nyman, Utlandsannon AB, S-106 12 Stockholm, Sweden. Tel: 46 879 66650 Fax: 46 861 33012 **Japan** Mr Haruki Hirayama, EMS Inc, 1-20-3-2F, Matsubara, Setagaya-ka, Tokyo 156, Japan. Tel: 81 3 3327 2688 Fax: 81 3 3327 3010

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Australian Association of Business Publications
CAB AUDIT

AEEMA export awards — call for entries

The Australian Electrical and Electronics Manufacturers' Association (AEEMA) is seeking entries for its third annual Exporter of the Year Awards to be presented in Sydney on September 24.

The awards seek to acknowledge the achievements of Australian companies in the telecommunications and energy/electrical industries in developing and maintaining overseas markets for their products and services. This is the third year the awards have been presented. Last year's winners were ATCO Controls and Stanilite Electronics, with Wilson Transformers, TechComm, Edwards Energy Systems, Alcatel Australia, JNA Telecommunications, Olex Cables and Radio Frequency Systems all receiving high commendations.

A total of four awards will be presented this year, with the award categories — Telecommunications Exporter of the Year and Energy Exporter of the Year — being split to include small exporters (under $25 million) and large exporters (over $25 million) in each category. The awards are open to both members and non-members of the association.

Alex Gosman, executive director of AEEMA, said the awards are designed to encourage more companies to increase their international activities and to acknowledge export excellence in these vital industries.

"With the separation of categories this year, we are expecting double the number of entries. The awards are becoming highly sought after and confer a high level of recognition on the winners," said Gosman.

According to Gosman, Australia's electrical and electronics industries are two of the country's most dynamic manufacturing sectors and are key elements to the supply of competitive energy and telecommunications systems. The industries have also been the major contributors to the dramatic increase in manufactured exports in recent years. In 1995, exports for electrical and electronic industries exceeded $2.3 billion, which is 12% of all exports of elaborately-transformed manufactured goods.

Over the past five years, the electrical and electronic industries have been the fastest growing sectors, with exports growing on an annual basis by 30%.

Entry forms are available from AEEMA, tel (06) 247 4655, fax (06) 247 9840.

AEEMA is the peak industry association, representing more than 250 local and international companies involved in the design, development and production of electrical and electronic products and systems in Australia. The turnover of these industries in Australia exceeds $12 billion annually and AEEMA members account for around 95% of this. Also under ☛

Sleeping with the US

Melbourne-based sleep and telemedicine innovator, Compumedics, has signed a $15 million export agreement with US sleep-disorder researcher ResMed. Under the agreement ResMed will distribute Compumedics sleep-disorder diagnostic equipment in the US and German markets.

David Burton, Compumedic's managing director, said the agreement would open the way for Australian technology to gain greater access to sleep disorder markets throughout the world. "Sleep disorders have been increasingly recognised around the world as a major medical problem," said Burton. "In the US there are over 1500 sleep laboratories in hospitals and clinics with special devices to undertake sleep monitoring and diagnosis of sleep apnoea, the most common sleep disorder for more than 20 million US sufferers."

Compumedics has pioneered the development, design, manufacture and sales of computer-based medical equipment for monitoring and diagnosing patients with sleep disorders in Australia.

Victorian Premier Jeff Kennett, who attended the signing of the export agreement, said the firm's agreement with ResMed was further evidence that Victoria was leading the country in the field of scientific and medical equipment, and the relationship between the two companies would deliver substantial economic and technological benefits to the state. ❐

From left, Professor Colin Sullivan, Jeff Kennett, Dr Johnathan Wright and David Burton signing the export agreement between Compumedics and ResMed.

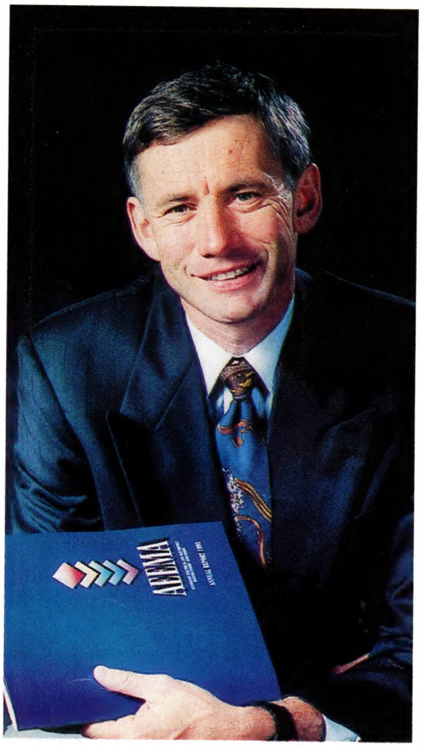
the AEEMA umbrella is the Australian Telecommunications Industry Association (ATIA), which provides a separate focus for telecommunications issues.

To be eligible for the awards, a company must export products and associated services that are considered telecommunications or electrical. Telecommunications is defined as any product of system that assists in the process of communication by electronic means, be it data, voice, video, etc. Electrical is defined as a product of electromechanical nature (such as transformers, cable and wire, lighting, appliances, accessories, etc). It can also include the design and installation of the exported products. The Australian content of the products must be at least 50% of the export sales value.

This year's awards are sponsored by the Export Finance and Insurance Corporation (EFIC) and Reed Business Publishing represented by Australian Electronics Engineering, Comms Network and Electrical World magazines.

Entries for the awards close on August 24, 1996.

For entry forms or further information about the Exporter of the Year Awards, contact AEEMA at Suite 404, 10 Moore Street (GPO Box 1966) Canberra City ACT 2601, tel (06) 247 4655, fax (06) 247 9840. ❐



Alex Gosman, executive director of AEEMA — "These awards are becoming highly sought after."

LATELINES

The Credit Unions Services Corporation has developed a Privacy Code of Conduct for reloadable stored value smart cards. The code was developed for credit unions to trial a stored-value feature on their cards. The code guarantees the separation of the information held on the chip from that held on the magnetic stripe on the card. The release of the code coincides with the first trial of such a card by The Universities Credit Union in Newcastle which has joined up with the successful Quicklink stored value program running there. Under the trial, members of the credit union will be issued with Redicards with the normal mag stripe as well as the Quicklink chip, enabling card users to pay for small purchases such as newspapers as well as use the debit function with EFTPOS and ATMs. ❐

The Australian Financial Review has reported that private investment company Blaironia has bought almost 3.5 million shares in HarTec, giving it a 15% ownership of the company. In a surprise move the managing director of HarTec Kevin McDonnell resigned around the same time, only shortly after formulating a rescue plan for the company. ❐

Melbourne company Lemvest has announced that it has bought some of Exicom's assets and will employ 140 of its staff. The Exchange weekly newsletter has reported that Lemvest bought 5.25 million worth of Exicom's stock and $1.7 million worth of plant and equipment. Last year Exicom earned between $40 and $50 million in revenue from the product lines acquired by Lemvest's subsidiary Com 10. ❐

Federal Science and Technology Minister Peter McGauran warned in mid-July that government departments and private industry are facing financial disaster due to their unwillingness to prepare for the "Year 2000 Computer Bomb". This phenomenon is so-called from the fact that most computer systems have not been programmed to cope with the new century. The change to 2000 will be read as '00' which is "invalid in computer logic". The minister said "As a result, up to 90% of systems will fail or revert back 100 years to the year 1900. The ramifications are enormous, especially for the finance sector. Routine procedures such as transferring money, collecting debts and payment of pensions will be thrown into chaos. Bills will not be paid, accounts will automatically be credited with 100 years of interest, and goods will not be delivered. While a number of government departments have been working on the problem for more than two years, I am concerned that others have been slow to respond. A Year 2000 Task Force has been set up by the government which is currently preparing a survey and checklist for all government agencies to ensure they are taking steps to safeguard their systems." The minister has also urged private companies to address the problem without delay, which for many organisations would mean thousands of lines of code a week being programmed and tested. The minister warned that "failure to take the necessary action could financially cripple some businesses, forcing them to close." ❐

Australian multimedia entertainment company Laservision has designed and installed the world's largest outdoor laser display in a Korean theme park. The display is expected to draw up to 30,000 visitors a day. Laservision was assisted by Austrade's Seoul office to win the $7 million export order ahead of tough international competition. The display features a fibre optic network and control system which is the result of ten years of Australian R&D. ❐

AMD has announced the shipment of its 100 millionth embedded DSP circuit. A brief ceremony was held at Supercomm '96 to mark the event. ❐

Exhibition space for Elenex is almost sold out, say the organisers Australian Exhibition Services. The exhibition is set to have more exhibitors than ever before in the show's eight-year history. Many exhibitors will be launching new products at the show, including B&R Enclosures and Micromax. Elenex is being held this year on October 8-11 at the new Melbourne Exhibition Centre. ❐

Powertel has been chosen as sole distributor of Keithley Metrabyte pc-based data acquisition cards, chassis and software for bench, lab and industrial process and control. The company is now developing a new electronic systems division. ❐

Hewlett-Packard's 100VG saves valuable classroom time

The Division of Electronics Technology at the Box Hill College of TAFE in Melbourne has installed a Hewlett-Packard 100VG network that it hopes will make it more competitive in the international education market. The Division currently derives 50 per cent of its revenue from private industry training, a figure that is growing each year.

Increasingly, the Division is being asked to provide training programs interstate and overseas in the highly demanding electronics area. This has meant the courses it offers must provide employers with a better trained, more job-ready applicant.

Mark Gibbs, an electronics teacher at the institute, said if the Division is to maintain its leadership position, it must continue to enhance its practical sessions. "One of the part-time courses we run is to teach students how to build a file server over a local area network (LAN). The 64-hour course of four hours per week includes two hours each week of practical training," Gibbs said.

"A problem we were facing was that it was taking around 45 minutes to download the Novell LAN software to everyone in the class before any practical work could be done. Obviously a teacher could preinstall the software before class, but we believe it is important for students to get the experience in doing this themselves."

A new LAN speeds learning — Mark Gibbs (standing) with two students from Box Hill College of TAFE's Division of Electronics Technology.

Gibbs said the time problem has been solved with the installation of a Hewlett-Packard 100VG-AnyLAN high-speed network. According to Gibbs, it now only takes three minutes to download the software simultaneously to all students, which leaves almost a full two hours to complete the lesson.

At the end of the four-month course, it is expected that every student in the class can build his or her own file server from scratch within the two-hour period. This includes installing log-in scripts, menus and applications.

"We run 18 LAN systems, nine on 100VG and nine on 10Base-T, so students have both systems in front of them. Novell 4.1 is installed on nine of the systems from the 100VG LAN. After installation, the file servers are rebooted in a 10Base-T environment. The 100VG cards automatically switch from 100VG to 10-Base T," Gibbs added.

The Division has one HP 100VG AdvanceStack hub in the LAN/data communications classroom and two 16-port 10Base-T switches with two 100VG uplinks, which control most applications in the building.

Following installation of the new network a number of side benefits were found. "If the system crashed or a problem arose," said Gibbs, "we used to call the technical staff straight away. If they were busy, the lesson would have been severely disrupted.

"Now, the Hewlett-Packard hub can tell us within one second which machine is causing the problem. More often than not, it is just a loose cable that can be fixed by the teacher in the classroom.

"It is faster for us to use the HP hub for fault-finding than it is to get out the test equipment," he stated. ❐

BEHIND THE COVER

The **ADSP-21062** and **ADSP-21060 SHARC** — Super Harvard Architecture Computers — are signal processing microcomputers that offer new capabilities and levels of performance. Available from **ICD**, the ADSP-2106x SHARCs are 32-bit processors optimised for high-performance DSP applications. They build on the ADSP-21000 DSP core to form a complete system-on-a-chip, adding dual ported SRAM and integrated I/O peripherals supported by a dedicated I/O bus. Fabricated in a high-speed low-power CMOS process, the ADSP-2106x has a 25ns instruction cycle time and operates at 40MIPS. With its on-chip instruction cache, the processor can execute every instruction in a single cycle.

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Benchmarks for the chips (@40mhz) include: 1024-Pt. Complex FFT (Radix 4, with digit reverse) = 0.46ms, 18221 cycles; FIR Filter (per Tap) = 25ns, 1 cycle; IIR Filter (per Biquad) = 100ns, 4 cycles; Divide (y/x) 150ns, 6 cycles; Inverse Square Root (1/√x) = 225ns, 9 cycles; and DMA Transfer Rate = 240Mb/s.

The ADSP-2106x SHARC represents a new standard of integration for signal computer, conbining a high performance floating-point DSP core with integrated, on-chip system features including a 4Mbit SRAM memory (2Mbit on ADSP-21062), host processor interface, DMA controller, serial ports, and link port and parallel bus connectivity for glueless DSP multiprocessing.

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High-tech distribution for the ADF

Ready, aim, fire! — the ADF keeps track of its inventory with barcode scanners linked to a wireless computer network.

In a cooperative tri-service — army, navy and air force — effort, the Australian Defence Forces (ADF) has streamlined its military hardware distribution channels with the installation of a sophisticated system of laser barcode scanners and RF terminals at its National Storage and Distribution Centre (DNSDC) at Moorebank, NSW.

The DNSDC is the largest single warehousing site in the southern hemisphere, covering a total area of eight square kilometres. The 40 warehouses supply all ADF operational units throughout Australia. The DNSDC despatched all the supplies and armament for the Australian forces effort during the Rwanda and Mogadishu crises.

The new inventory system, supplied and installed by TechComm, uses laser barcode scanners and RF and desktop terminals linked wirelessly to a central computer to keep track of all items in the huge inventory. The main computer is linked to the defence forces' ten other distribution centres around the country, and keeps track of over 850,000 separate inventory lines.

The integrated RF systems dramatically reduce the time needed to process incoming and outgoing shipments, and eliminate many stocktaking tasks. Inventory information is scanned and transmitted to the central computer in real-time, so manual uploading is not required. The system has led to a 70% saving in processing time for shipments entering the Moorebank facility.

Two 15-metre RF towers were built to give coverage over the entire site, enabling the wireless input terminal to be used in any location and remain in contact with the main computer. The towers each carry six radio transceivers as well as one hard-wired network, connecting eight additional transceivers.

The RF inventory system interacts with the Department of Defence host IBM mainframe at the National Defence Computer Centre in Canberra, to allow coordination of the DNSDC with other defence activities. ❐

Exhibitors rush for space at Electronica 96

The giant Electronica electronics trade fair held every second year in Munich targeting electronic components and assemblies, opens its doors to an expected flood of visitors from November 12 to 15 this year. According to the organisers, Messe Munchen GmbH, demand for exhibition space at this year's show is breaking records. Electronica 94 attracted some 2860 companies from 46 countries and saw over 85,000 trade visitors from around the world look through its cavernous halls. The organisers claim this year's show will be even bigger, and exhibition space is already at a premium.

The number of product categories to be displayed has also been increased from the '94 show. There are seven product categories included in the exhibition this year: microchip products; assemblies and other subsystems; discrete semiconductor components; other discrete components; system equipment; electromechanical components; system periphery; and ED/EDA equipment and laboratory metrology.

Events to be held in conjunction with the exhibition include a forum to examine microtechnology as a future market. The forum will look at areas such as micromechanics, microoptics and all associated interconnection techniques. The forum will be run by the Association for Microelectronics, Microtechnology and Precision Mechanics (GMM).

An important part of the events calendar will be the Electronica Forum, a podium discussion with world industry representatives, this year focusing on the topic "How the chip is changing society".

Anyone wishing to enquire about Electronica 96 should contact the **German-Australian Chamber of Industry & Commerce, tel (02) 261 4475, fax (02) 267 3807**, and quote *Australian Electronics Engineering*. ❐

New cabling standard

Standards Australia has recently released a new standard to provide a generic cabling system for all data protocols which will also allow integration of products from different vendors.

AS/NZS3080 standardises modular plugs and sockets, which will lead to economy of scale for manufacturers because it is no longer necessary to have a range of connectors for different cabling infrastructures. The standard also sets minimum performance measures for structured cabling, insuring active equipment manufacturers have a base level from which to design products.

Colin Browitt from the Standards Committee said "Standardising cabling infrastructure will benefit both the manufacturing side of the industry and the end-user in ways that will make the whole issue of cabling infrastructure cheaper and more flexible. The AS/NZS3080 standard document is available from all Standards Australia offices for approximately $70. ❐

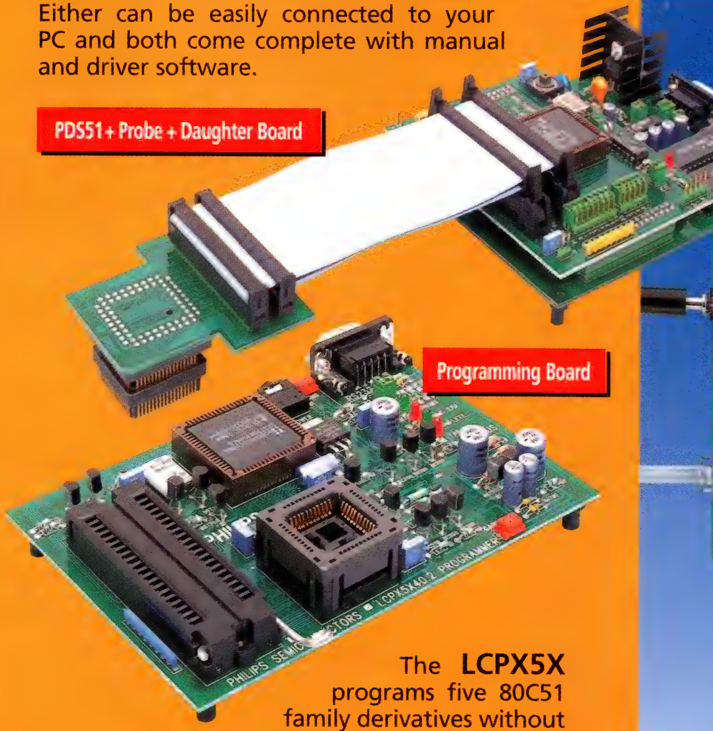
DEVELOPMENT SYSTEMS

80C 51

Philips board level in-circuit emulator for 80C51 microcontrollers and derivatives, the PDS51 utilises bondout silicon and offers transparent real time in-circuit emulation without stolen resources. This frees the user to concentrate on the project in hand, without obstructions caused by any development system deficiencies.

Probes and daughter board options are detachable and based on part number development. Options need to be determined at time of ordering.

For programming support of OTP/UV parts, use the LCPX5X or LCPX5X-40. Either can be easily connected to your PC and both come complete with manual and driver software.



PDS51 + Probe + Daughter Board

Programming Board

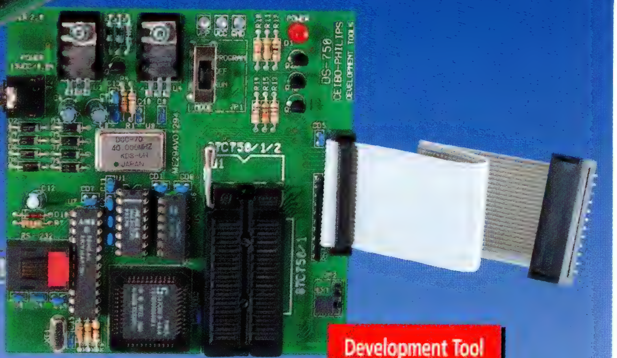
The **LCPX5X** programs five 80C51 family derivatives without additional adapters: 87C748, 87C749, 87C750, 87C751, 87C752, 87C451, 87C552. Four zero insertion force sockets.

The **LCPX5X-40** programs eight 80C51 family derivatives without additional adapters: 87C51, 87C52, 87C550, 87C575, 87C652, 87C654, 87C524, 87C528. Two zero insertion force sockets.

The DS-750 is a low cost development tool that supports Philips 87C750 microcontrollers at any frequency allowed by the devices. It is serially linked to a PC/XT/AT or compatible system and can emulate the microcontroller using either the built in clock oscillator or any other clock source connected to the microcontroller. The DS-750 development tool features are:

- Real Time Emulation for 87C750 and 83C750 Microcontrollers;
- Simulator and Simulator Plus Modes with Debug;
- Programmer for 87C750, 87C751 and 87C752 Microcontrollers;
- Source-level Debugger for C, PLM and Assembler;
- Runs under DOS & Windows™ software.

Windows is a trademark of Microsoft



Development Tool

For more information on Philips development systems, contact Arlec, the **National Distributor**.

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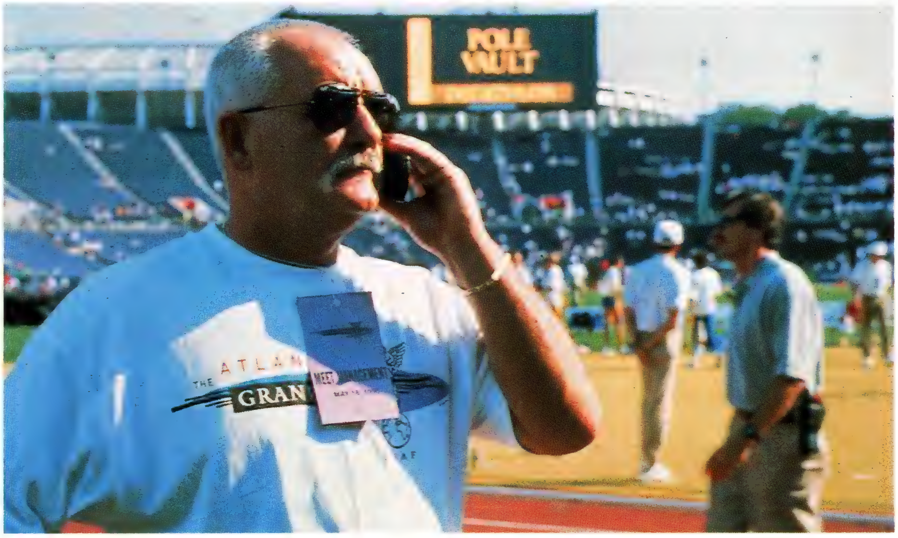
Communications of Olympic proportions

The Atlanta Olympics held last month saw more than just sporting records broken — it used the largest communications system ever created for a single sporting event, with over 10,000 portable and mobile two-way radios, 6000 pagers, 1200 cellular phones and 1500 computer modems linked to form an integrated system.

The system was developed by Motorola and used the company's ASTRO and iDENT digital technologies to link each Olympic venue, supporting a cast of thousands of security, transportation and event-management personnel.

Preparation for the event included a test model was assembled at Motorola's 38,000 square-foot Customer's Centre for Systems Integration in Schaumburg. The exact footprint of the network's layout in Atlanta was duplicated under one roof, including identical cable lengths and interconnections.

Mark Moon, Motorola's director of technology for the 1996 Atlanta Olympic Games, said that the ability to stage and test a system of this complexity is a unique service. "In less than three months the system was tested to the satisfaction of the Atlanta Committee for the Olympic Games (ACOG)," said Moon. "The digital two-way radio network is one of the most sophisticated wireless communications systems the world has ever seen." ❒



According to Motorola, its system for the Atlanta Olympics was the "most sophisticated wireless communications system the world has ever seen."

New player in local component distribution game

Back: Nick Lim (l), of BBS Electronics in Singapore and Tony Cooper, new business development manager for BBS Electronics Australia. Front: Behrouz Gholamrezaey (l), chairman of the BBS Group, and John Robinson, taking the helm of BBS Electronics in Australia.

Another player has arrived on the electronics components supply scene. BBS Electronics Australia, a subsidiary of the Singapore-based BBS Group of Companies, plans to make a marked impact on the local component supply business.

Also part of the BBS Group is BBS Electronics Pte Ltd in Singapore, an authorised distributor for high-profile electronic component giants such as AMD, Analog Devices, Augat, AVX/Kyocera, Bourns, and many others.

BBS Electronics Australia's managing director, John Robinson, said his company would offer specialised service to select customers with a strong emphasis on establishing effective supplier partnership arrangements.

Robinson, who has been involved for more than 25 years in the sales, marketing and distribution of electronics components in Australia with companies such as Texas Instruments, VSI Electronics and HarTec, said it was time to revert to the good, old-fashioned, personalised, customer service approach to doing business.

"The electronics component distribution market has changed dramatically in Australia," Robinson said. "The reality of the multinational, multi-aligned distributor is now here in Australia. However, there is a definite need for the smaller, independent distributor who can provide a full range and give focus to its activity."

Both Robinson and the BBS Group have invested considerably in establishing a business that they claim will serve the industry in a way other component suppliers have not.

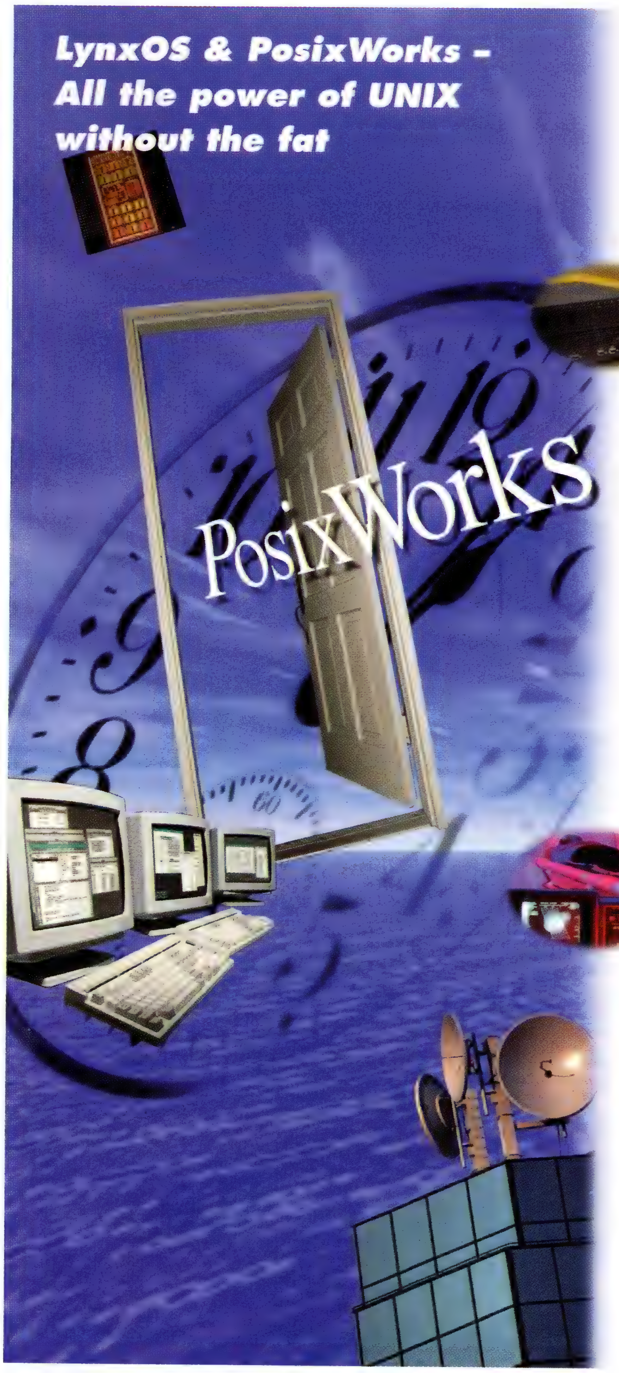
"I have learned a great deal about various customers, their specific needs and the necessity of valued-customer service," Robinson explained. "Customers are disillusioned by lacklustre service, and consistently-broken delivery promises."

The Australian office, established in Sydney's north west, has a facility for centralised customer service and warehousing. Robinson plans to establish sales offices in each major market region.

Robinson and recently-appointed business-development manager Tony Cooper, look forward to providing a serious alternative for local designers and electronics component purchasers who are looking for a component supplier who understands their needs.

"We will bring a new level of competitiveness, service and sanity to customers' businesses," said Robinson. ❒

LynxOS puts UNIX on a diet



The move is on to LynxOS. The open standard for deterministic, hard real time response.

While application developers have long been attracted to UNIX for its popularity, applications portability and rich system services, squeezing all that code into real time embedded targets was either impossible or too costly. Moreover, since it was created for work sharing, and not real-time, UNIX's nonpre-emptive kernel, inability to prioritise user tasks, and slow interrupt servicing ensured it could not fully satisfy real-time requirements.

That's where LynxOS comes in. It was designed from the ground up for complex, embedded real-time applications and wherever compliance to industry standards are essential. So now, developers get application portability standards like POSIX and UNIX APIs, with a blazingly fast, pre-emptible kernel, user prioritisable scheduling, and kernel threads for predictable and fast interrupt servicing – all in a compact ROM-able kernel that won't be a memory hog.

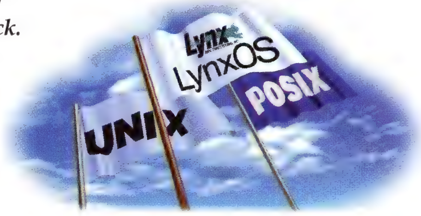
LynxOS is ideal for applications where memory is a premium and sophisticated, real-time capability a must. LynxOS can also be scaled up to become a self hosted development workstation complete with networking, windowing and software development tools.

LynxOS also conforms to POSIX 1003.1 and implements all of 1003.b (real-time) and 1003.c (threads) standards.

PosixWorks – The Real-time Integrator

PosixWorks fully integrates industry standard GNU C and C++ language tools, the TotalView debugger and TimeScan performance visualisation and analysis system with LynxOS. It supports systems ranging from compact embedded applications to complex, networked open systems, executing across multiple host platforms including Intel x86, Pentium, Motorola 680X0, PowerPC and SPARC.

Call VME Systems for a free information pack.



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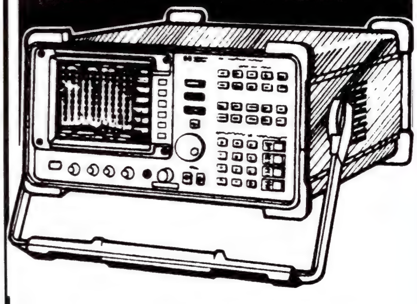

Rental is the answer

Renting the **Hewlett-Packard 84110EM** system is the answer to pre-compliance testing to EMC radiated and conducted emission standards. The system is based on the 8591EM spectrum analyser with matched antennas, near field probe, and an LISN.
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IN BRIEF

Siemens Semiconductor and Motorola Semiconductor are to build a joint chip plant for the latest generation fo DRAM memory chips, in Richmond, Virginia in the US. The White Oak Semiconductor plant is scheduled to begin production in the first half of 1998 and will produce 64 megabit memory chips on 200mm silicon wafers, beginning with a feature size of 0.35µm and scaling down to smaller geometries. The facility will use state-of-the-art environmental, health and safety systems to protect employees and the surrounding communities. These will include systems for chemical transport, storage and handling, and traffic noise and flow control. ❐

Rohde & Schwarz has established a web site offering four categories of information: What's New - press releases and news; About Rohde & Schwarz - overview, history, milestones, marketing addresses; Products, arranged according to activity fields and applications; and Events - the complete training program and a list of the company's participation in fairs for the year in advance. The address is http://www.rsd.de. ❐

Morris Productions has also set up a home page, containing information on products, services, technology and quality, as well as contact names and details. The address is : http://www.morris.com.au. ❐

AMD has annexed its programmable logic division into a separate, wholly-owned subsidiary with the aim of better serving its PLD customers. The plan is to provide the flexibility and focus of a small company with the resources of a parent company with world-class technology and manufacturing. ❐

Corcom, a US component manufacturer represented here by R&D Electronics has put its three catalogues on the internet - RFI power line filters, signal sentry filtered modular jacks, and power entry modules. The information includes dimensional drawings, test specifications, and distributor listings. Prospective customers can use the selector chart in each catalogue to find the product needed and then click onto a screen to request samples, giving engineers access to drawings and technical data on their screen. The address is: http://cor.com/home.html.❐

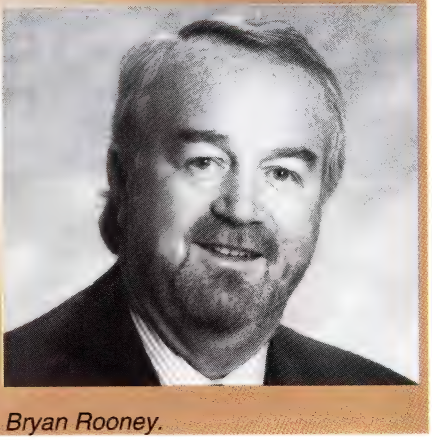
Compaq has chosen Cabletron Systems to become a Systems Management Partner, under which agreement Cabletron's Spectrum Enterprise Manager will be integrated with Compaq's Insight Manager, enabling Spectrum to manage Compaq systems within a distributed enterprise. Using its object-oriented intelligence, Spectrum will automatically discover and model all Compaq systems and their relationships and place them within a topology view of the entire network. Users can then graphically view the status of the network and obtain statistics on all its devices and applications. ❐

ON THE MOVE

Vince Stafrace, formerly of Elmeasco Instruments and Nilsen Technologies, is to head a new Electronics Systems Division for Powertel. The new division will market and support high-technology electronic test equipment. Vince has 11 years experience in the industry. ❐

Software company Micrografx Australia has appointed **Linda Birchall** as Marketing Services Coordinator to oversee marketing and PR activities in Australia and New Zealand. ❐

Component maker Burr-Brown has announced the signing of **Bryan Rooney** as Vice President of Worldwide Sales. Rooney comes to Burr-Brown for Brooktree Corporation where held a similar position. He has over 25 years experience in the industry and gained experience working with companies such as Analog Devices, Silicon Systems and Monolithic Memories. ❐



Bryan Rooney.

Just some of our new products

Product	Density	Org	Speed	Vpp	Package	
28F008SC	8 Mb	x 8	85, 120	3.3V, 5V or 12V	TSOP, PSOP	Vcc down to 2.7V
28F008BV	8 Mb	x 8	70, 120	5V or 12V	TSOP	Boot Block sectors
28F800CV	8 Mb	x 8 or x 16	70, 120	5V or 12V	TSOP	Boot Block sectors
28F800BV	8 Mb	x 8 or x 16	70, 120	5V or 12V	PSOP	Boot Block sectors
28F400SV	4 Mb	x 8 or x 16	60, 80, 120	5V or 12V	TSOP, PSOP	Boot Block sectors
28F200SV	2 Mb	x 8 or x 16	60, 80, 120	5V or 12V	TSOP, PSOP	Boot Block sectors
28F016SV	16 Mb	x 8 or x 16	65, 80	5V or 12V	TSOP, PSOP	High speed write
28F016XD	16 Mb	x 8 or x 16	85	5V or 12V	TSOP, PSOP	Extended DRAM architecture
28F016XS	16 Mb	x 8 or x 16	Ows 33Mhz	5V or 12V	TSOP	Extended SRAM architecture

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Augat has completed the acquisition of the fibre-optics products and technologies business of **Porta Systems Corporation**. The deal covers the products, technologies and contracts of Porta Systems' Aster and Porta fibre business units. Products include optical couplers, attenuators, fibre distribution equipment, cable assemblies and connectors. William Fenoglio, Augat's president and CEO said that "Augat will consolidate its fibre-optics research, development and certain production into an enlarged facility at the Augat-Aster location in Hopkington, MA in the US." ❒

Robinson Instruments, formerly Runcorn of the UK, a manufacturer of Partial Discharge test and measurement systems, has been acquired by the Hubbel Group of the US. Robinson's design and manufacturing operations have been merged with those of **Hiptronics** in New York. *Macey's Electrical* of Sydney, the representative for Hiptronics in Australia, will now provide full sales, service and technical support for all Hiptronics and Robinson products, covering existing equipment and new enquiries. ❒

Obiat has been appointed Australian agent and distributor for the **Analogic** range of data conversion products, miniature power supplies and data acquisition boards. Data conversion products include sampling A/D converters and 16 to 24-bit digitisers. Analogic also offers a range of low-noise dc-dc converters for use with high-performance DAC products, and various data acquisition boards for a range of applications. ❒

Nylon Products has changed its name, address and phone number. The new identity is NPA Pty Ltd, unit 15a/18-28 Gray St, Kilkenny SA 5009, ph (08) 268 2733, fax (08) 268 1455. ❒

New logic, memory subsidiary for National

National Semiconductor announced in June that it has formed a new subsidiary consisting of its family logic, memory and discrete businesses, to be called Fairchild Semiconductor. In the most recent quarter, these product lines represented approximately 25% of total sales and were profitable as a group.

Kirk Pond, the new entity's CEO, said "Fairchild intends to be a world leader in family logic, building on our large, loyal customer base for logic, as well as memory and discrete products...We will be careful to ensure a smooth transition of sales and service channels from National to Fairchild. In the short term we will be using National's worldwide sales and service channels while we formulate a transition plan, in concert with National and our customers."

National Semiconductor sites that will become part of Fairchild Semiconductor include the wafer fabrication plant in South Portland, Maine, USA; the wafer fabrication plant in West Jordan, Utah, USA; and the test and assembly plants in Cebu, the Philippines and Penang, Malaysia. ❒

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The PA People's rental division supplied communications and audio equipment for the Indy Car Race on the Gold Coast recently, including over 2.5km of multichannel cabling. Distribution amplifiers, line drivers, extensive signal patching facilities and a 24-channel mixing console formed part of the massive communications network assembled for the event, routing all voice communications between master control, the three outside broadcast vehicles, helicopter and Channel Ten's in-car camera, via a central communications patch matrix. ❒

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IT Solutions for Utilities *August 14–15,* Hyatt Regency, Sydney. Contact: IIR Conferences, (02) 9954 5844, fax (02) 9959 4684. ❒

Cards Australia '96 *August 20–22,* Sydney. Contact: AIC Exhibitions, tel (02) 210 5700, fax (02) 223 8216. ❒

Growing the high-tech enterprise — Manufacturing Strategy for high-tech enterprises *August 28,* Australian Technology Park, Redfern, Sydney. Contact: The Warren Centre for Advanced Engineering, Rm 203, Level 2, Engineering Faculty building J13, University of Sydney NSW 2006, tel (02) 351 3752. ❒

PC 96 *September 3–6,* Melbourne. Contact: Australian Exhibition Services, tel (03) 9867 4500, fax (03) 9867 7981. ❒

Elenex '96/SM '96 *October 8–11,* Melbourne. Contact: Australian Exhibition Services, tel (03) 9867 4500, fax (03) 9867 7981. ❒

Growing the high-tech enterprise — Encouraging entrepreneurs: how to build on their ability, *October 16,* Australian Technology Park, Redfern, Sydney. Contact: The Warren Centre for Advanced Engineering, Rm 203, Level 2, Engineering Faculty building J13, University of Sydney NSW 2006, tel (02) 351 3752. ❒

The Home Computer Show, *November 15–18,* Melbourne. Contact: Australian Exhibition Services, tel (03) 9867 4500, fax (03) 9867 7981. ❒

Networld+Interop 96, *November 25–29,* Sydney. Contact: Synergy Conventions, tel (02) 369 1242, fax (02)387 5482. ❒

ACOFT '96, *December 1–4,* Conrad Jupiters, Gold Coast, Queensland. Contact: Conference Secretary, ACOFT '96, IREE Society, P.O. Box 495, Milsons Point NSW 2061 tel (02) 9929 0099, fax (02) 9929 0587. ❒

Visual Basic '96 *December 2–4,* Melbourne. Contact: GUI Computing (03) 9818 6344, fax (03) 9818 7155. ❒

OVERSEAS

Surface Mount International: Advanced Electronics Manufacturing Technologies, *September 8–12,* San Jose, California, USA. Contact: Yolanda King, Miller Freeman Inc, tel +1 415 905 4994. ❒

Interfinish 96, 14th Interfinish Congress,*September 10–12,* Birmingham, UK. Contact: Interfinish 96 Secretary, IMF, Exeter House, 48 Holloway Head, Birmingham, B1 1NQ, UK. Tel +41 121 666 7190, fax +44 121 666 6316. ❒

Systems '96, 15th International Trade Fair for Information Technology and Telecommunications *October 21–25*, Munich. Contact: Tel +49 89 5107 461, fax + 49 89 5107 180❒

Wescon '96 International Electronics Conference & Exhibition/ IC Expo '96 *October 22–24*, Anaheim Convention Center, CA, USA. Contact: Wescon, 8110 Airport Blvd, Los Angeles CA 90045 tel +1 800 877 2668, fax +1 310 641 5117. ❒

19th Convention of Electrical and Electronics Engineers in Israel *November 5–6*, Jerusalem, Israel. Contact: ISAS International Seminars, P.O. Box 574, Jerusalem 91004 Israel, tel +972 2 652 0574, fax +972 2 652 0558.❒

Electronica 96, *November 12–15*, Munich Trade Fair Centre, Germany. Contact: Margaret Lamy, German-Australian Chamber of Industry and Commerce, Level 2 St Andrew's House, 464 Kent St Sydney NSW 2000 tel (02) 261 4475. ❒

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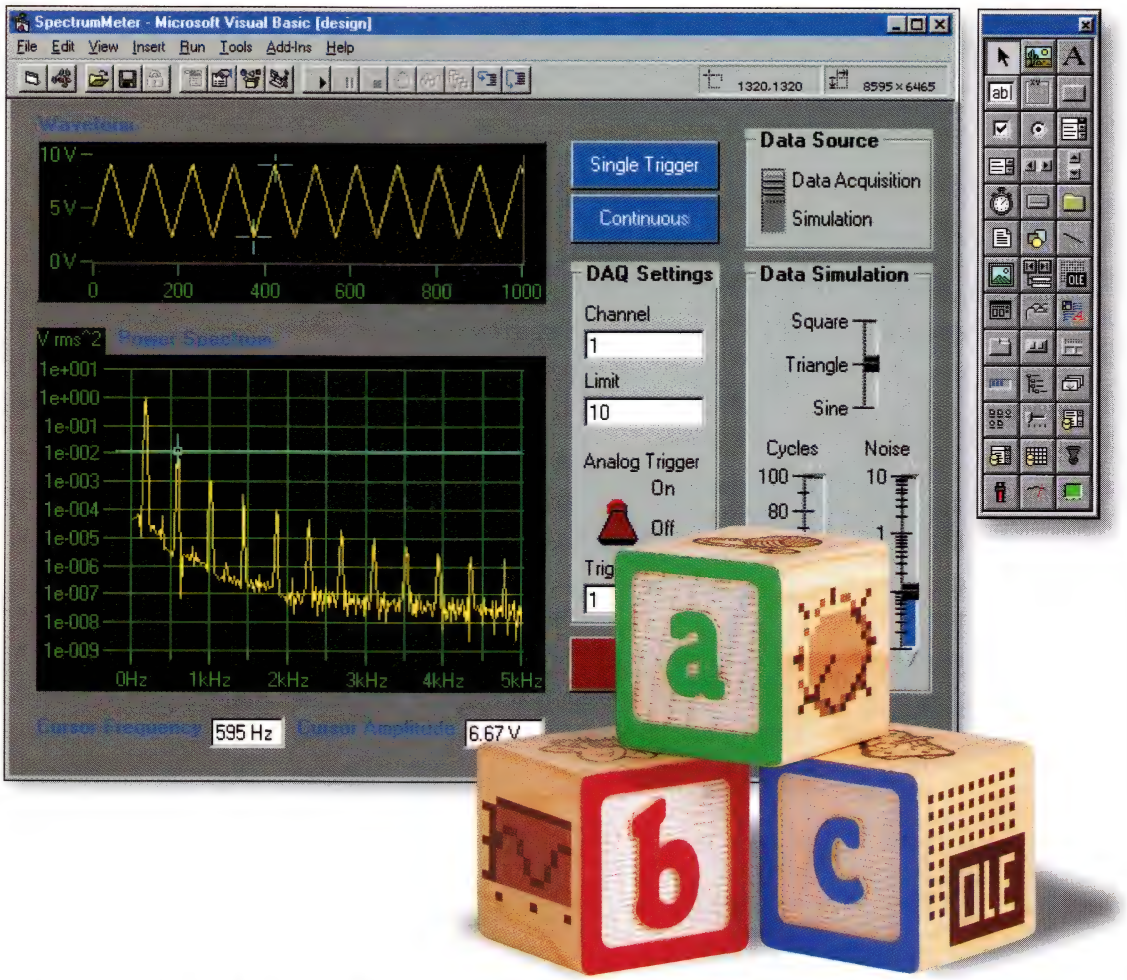

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– *Software Solutions*
March '96

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Smart cards

Revolution by stealth

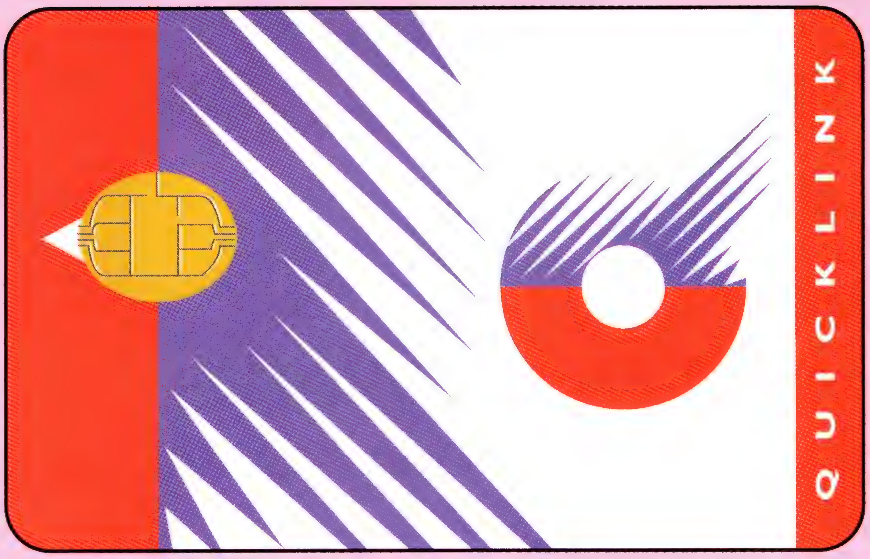
The "smart card revolution" seems at the moment to be a lot of hype with only scattered bursts of action. In this article we look at the current position of the Australian smart card industry, and what international clout it is likely to have when the wave finally breaks.

by Justine Geake

Rhetoric about a smart card revolution has been with us for some time. The Keating government was most vocal in its hopes and aspirations for this up-and-coming technology, with the Howard government showing every sign of doing the same. Stories abound in the media regarding the revolution in convenience for consumers, and issues surrounding the technology, such as privacy and security. The much-trumpeted "cashless society" still seems some distance off, however, and it would seem it is a process of evolution rather than revolution.

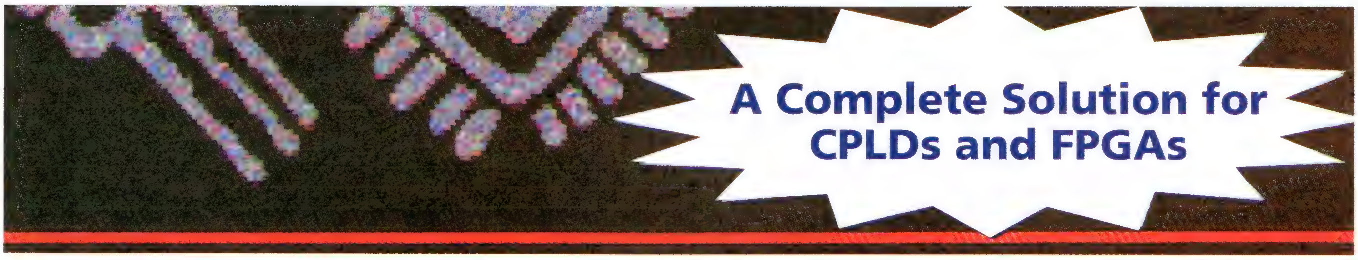
Despite all the hype, and predictions of the world market being worth $2 billion by the year 2000, the major players are taking it cautiously. While most in the industry seem to be awaiting their cue from the "big guns" (MasterCard, Visa and Europay), Australia's initiatives in this area are up there with the best. Our smart card industry is equipped with every necessary technology except the actual chips and is paddling along, looking over its shoulder, just waiting for the real wave to come; and when it does, it seems certain we'll be cruising out the front, surging Asia-wards.

Everyone agrees that the widespread use of smart cards is inevitable. What is being discussed now is who, how and when. Australia has two main advantages in the smart card game. It has been keeping pace with European and US developments, being one of the leaders in the design of systems and encryption methods, and it is next to what is considered internationally the hottest and biggest global market for smart cards, ie. Asia. Australia's population means that our home market is small and is not considered to be where our main opportunities lie. Europe is currently not a real option, as our smart card imports would attract a 12-13% duty, making it very difficult to compete with the European manufacturers (though we impose no duties on them). The US has been resistant of recent years quite to technologies developed outside its own industry, and its enthusiasm for smart cards has so far been slow. While Siemens predicts that by the year 2000, the US, Europe and Asia would each be about 30% of the market, for the moment it is clear that Australia's big opportunities lie with Asia, with projections of 500 million smart cards in use in the Asia Pacific region by the turn of the century.



One of the big advantages of the Asian market is that it is does not have the magnetic stripe infrastructure that is ubiquitous here, meaning that that technology will essentially be bypassed and large parts of Asia will go straight to smart card technology. Singapore has already declared its intention of becoming a cashless society by 2000. Battery-operated smart card readers which do not need an electronic line to a bank will mean that remote areas can be serviced, making the technology much more accessible to less prosperous areas without traditional infrastructure. Asia also has the population to make a thriving Australian smart card industry possible.

One industry source commented to *AEE* that another jump the Australian smart card industry has on Asia is that currently the large card manufacturers



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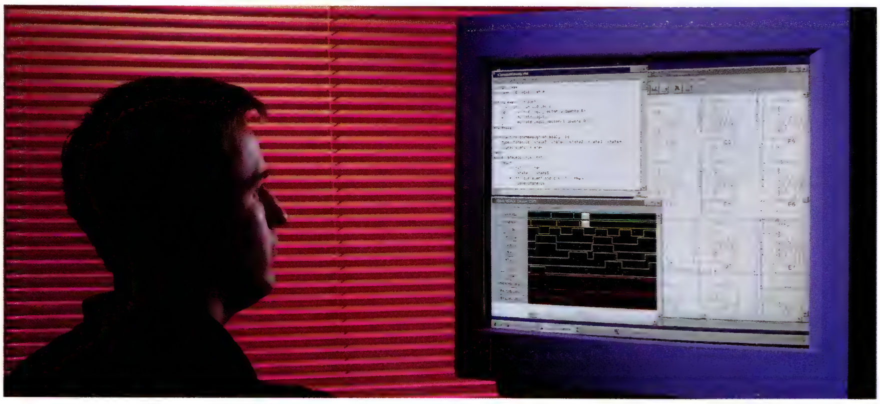

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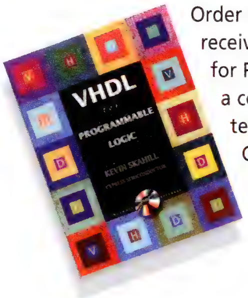

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do not consider that the degree of security necessary to manufacture smart cards is possible in Asia, whereas Australian businesses are able to guarantee the necessary security.

Furthermore, industry research has suggested that the Asian market will be interested in purchasing complete smart card systems, with ongoing support. Since the opening of Cardcorp's smart-card manufacturing facility last year in Sydney, Australia is now able to offer complete smart card technology systems. The only part of the whole system not produced in Australia is the actual chip, still sourced overseas.

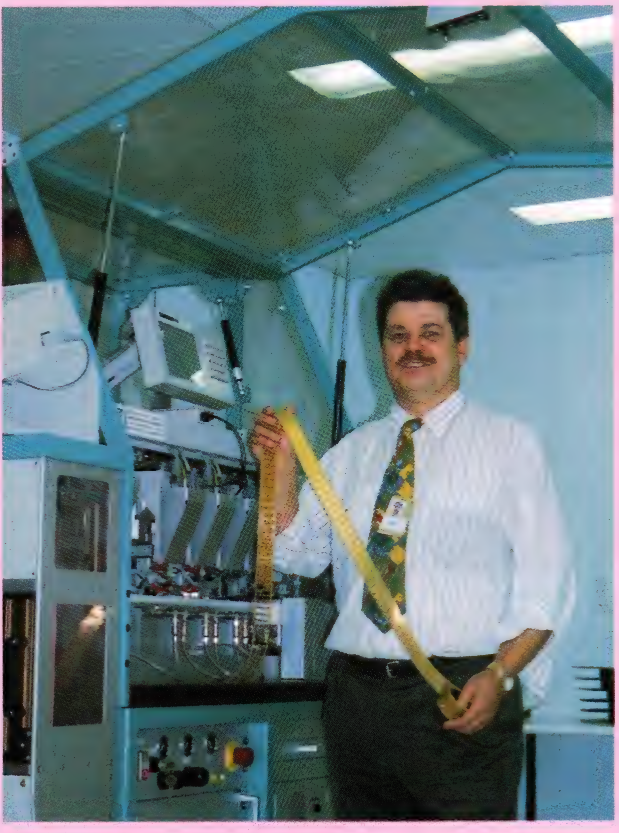
However despite all the pluses of approaching the Asian market, Siemens sees the difficulty of integrating the many Asian cultures into the one technology as being a formidable task. Electronics magazine EDN Asia commented that local Asian smart-card companies have the advantage of experience in microcontroller-based design, tight links to the rest of Asia, and access to low-production costs based in China.

Australia is seen internationally as a good test site for new technologies due to our traditional quick uptake and acceptance of them, hence the healthy number of trials being conducted here — four different trials are either running or have been completed, the most of anywhere in the world. Trials conducted so far include: Transcard, a Card Technologies Australia (CTA) stored value card which is contactless and reloadable and was trialled in Sydney's west; Quicklink, a contact reloadable card which was trialled in Newcastle; Visa Cash, a stored value disposable card trialling on the Gold Coast, and MasterCard Cash, a normal MasterCard credit/debit card with stored value capability, running as a trial in Canberra.

Results from the trials have been positive but not overwhelming. While Philips claims it has had an order from CTA for a million chips for national rollout of the Transcard, outcomes from the other trials have been less tangible.

Perhaps the reason for the industry's reticence to be the first to commence large scale rollout is the pace of change and development of new technology. One system is still being piloted when another is introduced which leapfrogs over it. Another problem is that no parts of the industry seem to agree at the moment on where the real future of the smart card lies. There are several systems being trialled internationally, and it seems that at least three or four will run in parallel for quite some time to come. All of these (namely MasterCard, Visa, Europay and quite probably Mondex) are currently contact cards, and the weight of their international presences will ensure their widespread use.

These cards' format is likely to be a multi-function card, like that currently being trialled by MasterCard, with credit/debit, stored value and EFTPOS on the one card (with the exception of Mondex which is currently stored value only.)



Do you see what IC: Ian Neville, Managing Director of Cardcorp, with a strip of chips for embedding in SIM cards, beside the machine which does the actual embedding in the company's facility at Rydalmere, Sydney.

The future of contactless cards seems to be more limited, probably limited to use mainly in public transport, though they are currently being touted as the stored-value solution for small purchases as well. However there seems to be general agreement that the future of disposable stored-value cards will be short and sweet indeed. A recent survey cited by MasterCard found that 76% of the survey's respondents would prefer to add a stored value feature to their existing credit or debit ATM card rather than having a stand-alone or disposable card — understandable, given most people's already unreasonable load of wallet plastic.

Another impediment to widespread rollout of a full smart card system is the enormous investment needed in infrastructure, with the need for a majority of merchants having smart card terminals before people start to genuinely rely on their smart card instead of on cash. Keycorp feels it is well positioned to cash in on this as 40,000 of its EFTPOS terminals already installed here are smart-card capable, needing only a simple modification to enable the feature.

While the technology involved in smart cards has been evolving in leaps and bounds, debate on the issues surrounding them, such as privacy, has not kept pace. To try to address this, in September 1995 the Asia Pacific Smart Card Forum (APSCF) was launched to promote the smart card industry in Australia, to ensure standards are in place for manufacturing, to develop a code of conduct for those in the industry, and try to resolve the impediments to the industry's growth.

Glenn Carlos of the APSCF sees the three main impediments to the industry's growth as the need for effective resolution of privacy and security issues, the need for real interoperability between all the various systems, and public education — until businesses and government departments can see how the technology can be applied to their enterprises, it won't become widespread. The tackling of all of these concerns necessarily will take a lot of time, debate and resources, and it becomes clearer in the light of this why the so-called "revolution" is failing to appear as such.

So far the Forum has produced a draft code of conduct, and in May launched a multilingual smart card brochure on Australia's capabilities, in Mandarin, Thai, Korean and Indonesian. The Forum has also been working closely with Standards Australia on coming up with appropriate standards for Australian conditions, using as a starting point the European ISO and ICE standards. About half of the European standards have been passed by the relevant committee as being acceptable and the rest need Australian modification. The first lot of international standards will be published as Australian standards by the end of the year. At the moment there has been no agreement to publish any standards for contactless technology, which is a more complex area.

There is no doubt that when confidence in the technology rises in the industry and in the general community, there

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4.8	MAX6315US48D1	MAX6315US48D2	MAX6315US48D3	MAX6315US48D4
4.7	MAX6315US47D1	MAX6315US47D2	MAX6315US47D3	MAX6315US47D4
4.6	MAX6315US46D1	MAX6315US46D2		MAX6315US46D4
4.5	MAX6315US45D1	MAX6315US45D2		MAX6315US45D4
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•	•	•		•
3.1	MAX6315US31D1	MAX6315US		MAX6315US31D4
3.0	MAX6315US30D1	MAX6315U		MAX6315US30D4
2.9	MAX6315US29D1	MAX6315U		MAX6315US29D4
2.8	MAX6315US28D1	MAX6315US		MAX6315US28D4
2.7	MAX6315US27D1	MAX6315US27D2		MAX6315US27D4
2.6	MAX6315US26D1	MAX6315US26D2		MAX6315US26D4
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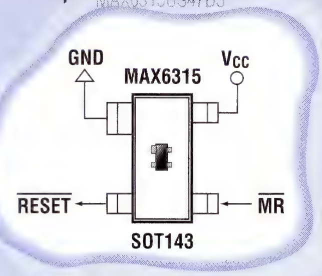

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are huge windfalls waiting for the Australian industry. In June, four of Australia's leading banks agreed to use the Mondex smart card system, creating a very big opportunity for Keycorp, which was confident of winning Mondex certification for its EFTPOS terminals, having already won Visa certification. An article in the Australian Financial Review quoted Keycorp managing director John Wood on the company's terminals' capability of soon supporting all the smart card technologies around. "We got in early and that counts for a lot. Mondex, Visa and MasterCard are all proactively helping us in export markets." However the Mondex rollout is not expected until late 1997. Wood estimates Australian sales of their smart-card-capable terminals to reach $50m in 1997.

A brochure on Australia's smart card capabilities brought out last year by University of Sydney's Warren Centre for Advanced Engineering said there were five manufacturers of smart card terminals in Australian at the moment — Ingenico, Fortronic Technologies, Hypercom, Keycorp and Intellect. While there is still only one card manufacturer, Ian Neville, managing director of Cardcorp, feels there will only be market enough for two when full multi-company rollouts begin.

Other Australian industry initiatives so far include: National Business Systems' provision of an embossing system for smart cards in Canton, China; Security Domain providing consultancy services to Singapore's NETS stored value card project; Cardcorp is currently negotiating with companies in Thailand and Indonesia regarding exporting cards; ERG, through its subsidiary AES Prodata, has provided an automated fare collection system for the State Transit Authority in NSW, whereby smart cards are used by bus drivers and inspectors as identificaiton cards to access the fare collection system on vehicles and to transfer information between the Authority's mainframe and the vehicle's system; AES Prodata has also developed the world's largest contactless smart card fare collection system in Hong Kong, allowing passengers to travel on bus, ferry, rail or tram using the one card; AES Prodata has also won a major part of London Transport's tender to install a contactless card trial in Harrow, London, which was highly successful and has recently gone to tender for a similar system for London's buses and Underground. The company has also been selected by a transport operator in Gothenburg, Sweden to upgrade their magnetic stripe tickets to contactless technology. Melbourne's Public Transport Corporation has also commissioned ERG subsidiary OneLink Transit Systems to design, supply, install and operate their entire fare collection system, covering bus, rail and trams with both magnetic and contactless cards. The system will be operated by OneLink for at least ten years.

Applications for smart cards either already in existence or just around the corner include using a smart card to pay your electricity bills by swiping it in your own meter; home shopping; pay TV; home banking; interactive TV; controlling PC access, electronic data interchange, high speed toll paying, and medicare cards. It seems Australia's potential as a world leader in smart card manufacturing and technology may only be limited by our industries' traditional reluctance to invest in new technology, and by our own imaginations in coming up with possible uses of it. ❐

Cards Australia 96

Conference and exhibition
August 20-22, Sydney.

Cards Australia 96, being held in the Sydney Convention and Exhibition Centre at Darling Harbour, promises to be a watershed for Australia's burgeoning smart card industry. A joint collaboration between AIC Conferences and the Warren Centre for Advanced Engineering at the University of Sydney, the event consists of a conference and an exhibition on all types of cards — credit, loyalty, purchasing, security and smart cards. The event will be highlighting the Australian smart card industry and pointing at directions for the future, covering the latest technology affecting smart card applications, the security issues involved and current and potential uses of stored value cards. The exhibition will enable attendees to see, touch, try, and test the various technologies available, in the contexts of marketing, finance, transport and leisure. Entrance to the trade show is free for members of the industry.

The conference covers three days with common first and third days, and the second day streamed into either smart cards or co-branding and loyalty schemes.

Highlights of the conference will include: **Gaylon Howe, Senior Vice President with Visa International, USA** speaking on the future of stored value cards including the results of worldwide Visa Cash pilot programs; **John Wood, Managing Director of Keycorp Australia** speaking on data security of financial transactions; and **Bruno Lassus, Marketing Manager, Healthcare with Gemplus International, France** speaking on healthcare smart card applications.

Francis Christian, Applications Manager-Smart Cards with Motorola USA will be speaking on whether the market and technology are in step for contactless technology. Francis is currently a market development engineer for Motorola Semiconductor products sector, focusing on applications for contactless cards. He is a member of the US Smart Card Forum and is on US standards committees for the development of contactless technology standards. (PIC COMING)

Other topics to be covered include overcoming technical problems and consumer reluctance with regard to stored value cards; an update on the MasterCard Cash trial running in Canberra; what UK banks are doing with smart cards; an examination of the legal issues surrounding cards-based electronic payments; and evaluating the business case for a smart card system.

To register or obtain further information, contact **Erika Morton** at **AIC Conferences** on **(02) 9210 5700** or fax **(02) 9223 8216** and quote *Australian Electronics Engineering*.

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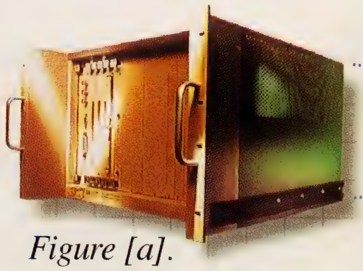

Figure [a]. Our VXI subsystem

Figure [b]. Your rack.

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Components

This month's product survey presents the latest in Components. For more information on any item, complete the Enter Card on pages 18 or 58 of this issue.

First wavelet compression IC

Analog Devices, available through Hartec, has released a wavelet-based video compression IC. The Analog Devices ADV601 Video Codec supports from visually lossless to 350:1 realtime compression and decompression of broadcast-resolution digital video (CCIR-601). The company is targetting the new device at the PC video capture and editing market.

Symmetry, scalability, precision and error-tolerance are key advantages of wavelet mathematics, which has benefits for a variety of signal processing applications, including video processing and communications. In wavelet compression. the silicon required for encoding is virtually the same as the silicon required for decoding, making the cost of encoding and decoding equal. Another advantage is that wavelets are a scalable solution which can be adapted to the transmission infrastructure. The bit stream can be edited on-the-fly and scaled for viewing at whatever resolution and frame rate the target system or transmission channel can support. This is important for video where screen resolution varies, as well as for communications where line bandwidth varies. Precise bit-rate control is also important in many signal processing applications where defined transmission rates must be maintained. [841](7327)

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Programmable IC monitors analogue signals

IMP, represented by Veltek, has announced what it claims is the first user-programmable monitoring and diagnostic data acquisition IC, which is the second member of its Electrically Programmable Analog Circuit (EPAC) family. The IMP50E30 integrates the functions of over 18 discrete analogue and digital CMOS IC components to provide a flexible solution for monitoring the status of analogue signals, detecting system faults, supporting preventative maintenance, or advising the level of system perishables and consumables.

Programmable analogue and mixed-signal building block resources that are integrated into the IMP50E30 silicon include level and window comparison circuits, a serial analogue-to-digital converter, a 16-channel single ended or 8-channel differential-input multiplexer, a manual and automatic channel scanner, a programmable-gain instrumentation amplifier and an input filter. Preconfigured utility blocks include a watchdog timer, voltage reference, input-connectivity or impedance monitor, general purpose operational amplifier and a sequence controller. Using Analog Magic software development tools, these capabilities can be configured by the user in a variety of modes and settings through the dual EEPROM/SRAM architecture. The same resources can also be reconfigured in-system via a host microcontroller in microseconds.[841](3946)

ENTER 2801 ON CARD

16-bit DSP family

Veltek has announced from Motorola Semiconductors, the DSP56L811, the first part in Motorola's new 16-bit DSP family. The CPU consists of three execution units operating in parallel, allowing up to six operations during each instruction cycle. The MPU-style programming model and optimised instruction set allow straightforward generation of efficient DSP and control code. The DSP56L811 supports program execution from internal or external memories. Two data operands can be accessed per instruction cycle from the on-

August/September 1996

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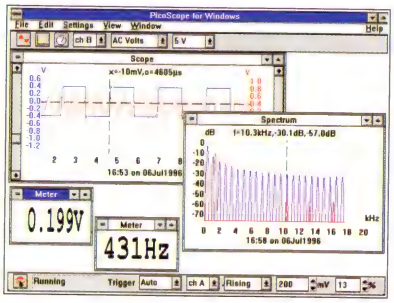
Introduction

The ADC200 simply plugs into the parallel port of your PC, no complicated setting up - just run the PicoScope for Windows software and start measuring. By making full use of the Windows environment, it is possible to view the signals on each channel in several ways simultaneously. Notice that the screen shot above shows the four instruments running simultaneously.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Large Memory for Fast Data Collection

The ADC200 has a much larger memory than most DSOs: 8K per channel. This affords users of the ADC200 some of the luxuries enjoyed by users of high end, expensive DSOs, such as capturing large amounts of data over a longer time period, or capturing short bursts of data with a great amount of detail.

Pre and Post trigger delays can be selected in 1% increments, ensuring that the required part of the waveform is captured.

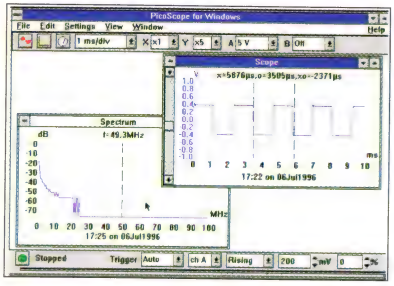
'One off' Events Captured in Real Time

To assist in locating intermittent faults the ADC200 has two special trigger modes. The first is a 'display overwrite' mode: the scope is left running continuously. Any differences from the normal waveform will be clearly highlighted on screen.

The second special trigger mode is a single shot/write to disk mode. The trigger can be set to capture only out of range signals with the scope again left running continuously. Later, all recorded events can be reloaded and examined.

Two Versions Available

The ADC200/50 performs as a 50MS/s DSO with scope and spectrum analyser operation up to 25MHz, while the lower cost ADC200/20 performs as a 20MS/s DSO with scope and spectrum analyser operation up to 10MHz.


1 ms/div · X x1 · Y x5 · A 5 V · B Off
Stopped · Trigger Auto · ch A · Rising · 200 mV · 0 %

pico

AEE readers quote	*8100*
WNIE readers quote	*T200*
EN readers quote	*230*

TekTools

Scope Display DMM

Tektronix' WaveMeter is a 3 ¾ digit autoranging TRMS DMM with 5MHz scope display.

For technicians and engineers who need a convenient way of quickly checking the waveshape of a measured signal, as well as checking for noise, glitches and distortion.

The basic DC accuracy is an adequate 0.3%.

Display resolution is 128 x 64 dots, with backlighting.

Tektronix

AEE readers quote	*8101*
WNIE readers quote	*T201*
EN readers quote	*231*

DMM Mode
- 4000 Count Display
- Autoranging
- V DC & A DC
- V AC & A AC True RMS
- Ohms
- Frequency
- Diode
- Continuity

SCOPE Mode
- 5MHz scope
- 16MS/s digitiser
- AC/DC V & A
- Scale, Position and Trigger Controls
- Pre, Post & Centre Trigger
- Auto/Manual Ranging

The Ultimate DMM

The DMM870 offers extraordinary reliability and confidence of measurement with 0.06% accuracy & 4 ¾ digit resolution.

The DMM870 offers all the measurement facilities listed on the right, plus the convenience of simultaneous dual measurements, and the ability to measure spikes & inrush currents using the high speed peak hold, even with time stamping information.

Tektronix

AEE readers quote	*8102*
WNIE readers quote	*T202*
EN readers quote	*232*

- 40,000 Count Display
- Dual Display
- Centre/Zoom Bar Graph
- Autoranging
- V DC & A DC
- V AC & A AC True RMS
- Ohms
- Frequency
- Capacitance
- dB and dBm
- Temperature
- Diode
- Time Stamp
- 1ms Peak-Hold
- Auto Hold
- Hi/Lo Limits
- MIN/MAX/AV
- Memory
- Delta Mode

TekScope

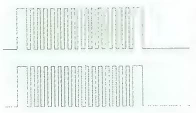
True 500MS/s Digital Storage Scope

Tektronix THS720 TekScope combines a full featured 100MHz Digital Real Time oscilloscope with a True RMS digital multimeter and data logger, in a rugged, affordable, battery operated instrument.

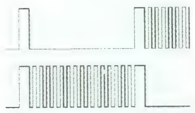
Why You Need One ADC per Channel

An easy test for a scope: connect both input channels to the same test point and try capturing a repetitive or even better, a single shot event.

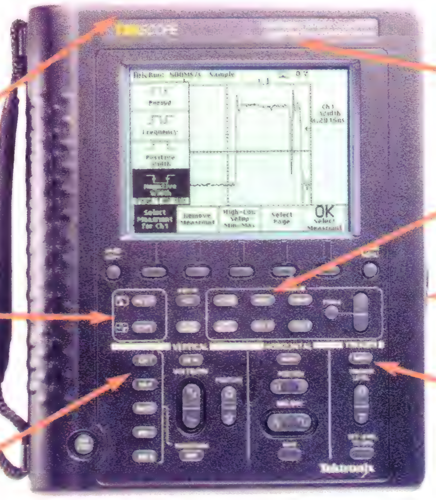
The diagrams below illustrate the difference between scopes with a time-shared digitiser or dual ADCs.



*Scope with **Dual Digitisers**: both channels tied to a single test point: reliable display.*



*Scope with **1 Digitiser**: both channels tied to a single test point: unreliable display !*



Each channel is independently isolated from chassis and other channels

True RMS autoranging DMM with data logging

__Dual digitisers__ for full bandwidth and sample rate on each channel

"Digital Real Time" technology captures what other scopes miss

21 automatic measurements

RS-232 computer and printer interface, with in-built printer drivers

Advanced triggering, including pulse width and video

Tektronix

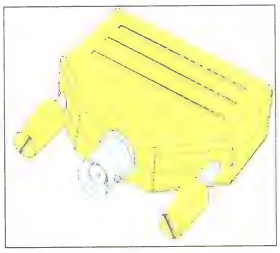
AEE readers quote	*8103*
WNIE readers quote	*T203*
EN readers quote	*233*

PC-Based Data Loggers

From 1 to 22 Channels

A unique range of small, voltage input instruments which connect to the PC's or Laptop's external parallel or serial port.

The software for each instrument includes Pico's very flexible Data Logger/Chart Recorder software package, PicoLog, which allows recording of signals over a few seconds to days or weeks. The recorded data can be exported to other packages or printed, as required.



pico

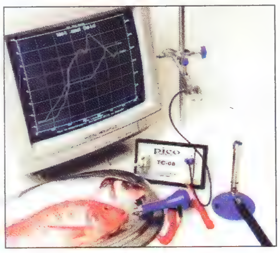
AEE readers quote	*8104*
WNIE readers quote	*T204*
EN readers quote	*234*

8 Ch Temperature Logger

Pico's TC-08 is a low cost thermocouple to PC interface with 8 inputs. It connects directly to the PC's serial port.

Seven different types of thermocouples can be used: B, E, J, K, R, S & T.

PicoLog Data Logger/Chart Recorder software is supplied as standard, offering advanced temperature logging and data processing functions. Data can be displayed in real time, graphed, tabulated, or printed.



pico

AEE readers quote	*8105*
WNIE readers quote	*T205*
EN readers quote	*235*

Laboratory DC Supplies

General Purpose DC Supplies

GW produces a wide range of affordable DC power supplies, with single and triple outputs, and analog or digital readouts.

Some of the models stocked by Emona incl:

GPS-1830 1 x 0 to 18V/3A
GPS-1850 1 x 0 to 18V/5A
GPS-3030 1 x 0 to 30V/3A
GPC-3030 2 x 0 to 30V/3A & 1 x 5V/3A
GPC-6030 2 x 0 to 60V/3A & 1 x 5V/3A

GW

AEE readers quote	*8106*
WNIE readers quote	*T206*
EN readers quote	*236*

DC Source Test Instruments

Electronic Loads Thoroughly Test Any DC Source

DC Electronic Loads are dedicated instruments for quickly and efficiently testing the performance and stability of any DC power supply or DC source.

Replacing the traditional methods of testing DC sources with banks of power resistors and 3 or more measuring instruments, Kikusui's DC Electronic Loads provide:

- A single compact instrument with integral V, A & W meters.
- Multiple Static & Dynamic Testing Modes.
- Safety in testing high current sources.
- Stand alone front panel programmability.
- PC-based programmability.
- Simple Master/Slave control of multiple units to increase load capacity.

Kikusui units offer up to five operating modes, including:

(1) Constant Resistance Mode **(2)** Constant Current Mode **(3)** Constant Power Mode **(4)** Constant Voltage Mode & **(5)** Dynamic Load testing (switching between 2 preset load settings with variable frequency & duty cycle).

Individual Kikusui DC Electronic Loads are available from 70W to 1000W. Multiple units may be connected in parallel to increase capacity to several kilo watts.

KIKUSUI

AEE readers quote	*8107*
WNIE readers quote	*T207*
EN readers quote	*237*

RF Test Instruments

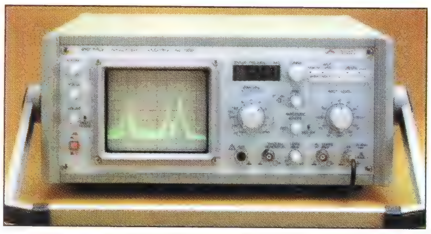
Affordable Spectrum Analysers from around $5,000

Promax, a specialised European manufacturer of test equipment, offer 2 professional RF spectrum analysers, with frequency ranges of up to 1.75GHz.

Promax spectrum analysers are outstanding for their simple operation, their on screen dynamic range of 80dB and their ability to display from 1MHz to 1000MHz in a single sweep.

Standard features include:

- automatic selection of optimum resolution bandwidth;



- log (dB) and linear (DIV) display modes;
- switchable 50ohm and 75ohm input;
- 120dB total dynamic range;
- normalisation function to correct for effects of cables, connectors, etc;

The AE-566 is Promax' top of the line, high accuracy 1GHz analyser with built-in tracking generator.

The 1GHz AE-366 is lower in cost, without tracking generator. It is ideal for TV and CATV applications.

The CV355 option extends the input range of the AE-566 & AE-366 to 1.75GHz.

PROMAX

AEE readers quote	*8108*
WNIE readers quote	*T208*
EN readers quote	*238*

TekBench

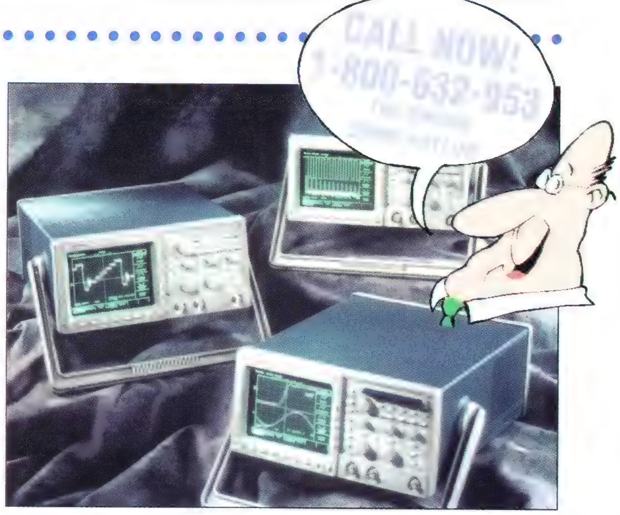
"Overpowered - Underpriced" Digital Real Time Scopes

Tektronix' affordable TDS-300 series offers the user brilliant signal capture, display and measurements facilities at unheard of prices in 100MHz, 200MHz and 400MHz bandwidth Digital Real Time scopes.

- **In-built FFT** for simultaneous spectrum analyser and scope display.
- **In-built MD-DOS™ floppy drive** for quick and easy transfer of data points and waveforms (PCX, TIFF, etc) to PC programs (200/400MHz models only).
- **Five times oversampling** on each input offers true high speed single shot signal capture of real-world signals at 2GS/s, 1GS/s and 500MS/s.
- **Traditional Delayed Timebase** for zoom and accurate signal measurement.

As well, the TDS 300's include 21 automatic measurements from frequency and time measurements to RMS voltage calculations and various maths functions.

Priced from just **$3,995**, excluding tax, for the 100MHz dual channel model, Tektronix now offers unbeatable value in high performance scopes. Call now!



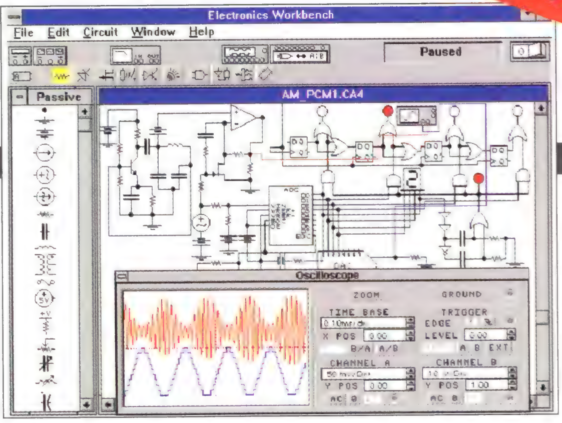
Tektronix

AEE readers quote	*8109*
WNIE readers quote	*T209*
EN readers quote	*239*

Engineering Software

Better Designs - Faster

PROTEL™ interface now available



Guaranteed with Electronics Workbench

Just click and drag to create and edit circuits. Mix analogue and digital devices in any combination with full control over values, component models and behaviour. Try 'what if' scenarios and fine tune effortlessly. And on-screen waveforms always match actual circuit response. You'll create better designs faster - Guaranteed!

Guaranteed Satisfaction

Join over 70,000 customers and experience the power, flexibility and value that only Electronics Workbench offers. Receive unequaled service and free, unlimited local technical support by phone, fax, e-mail and also Interactive's WWW, CompuServe and BBS. You'll be delighted.

True Mixed-Mode Power

Connect any analogue or digital device to any other device without limit.

Integrated 32-bit SPICE analogue and native-mode digital simulation.

Real-World Digital

Real-world TTL and CMOS, complete with propagation delays and fanout. Unique at this price.

Real-World Results

Unlimited supply of over 200 device and IC types providing 350 real-world component models, with another 2,100 component models available as Model Sets. All perform as real devices do.

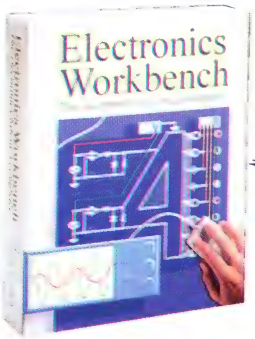
Netlist Connectivity Option

With the SPICE I/O option your designs can be imported and exported to other SPICE-based simulators such as PSpice and MicroCap.

PCB Export Option

The optional PCB Export will enable you to export the schematic files into popular PCB design packages such as Protel, OrCAD, Tango and others.

Electronics Workbench



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INTERACTIVE

AEE readers quote	*8110*
WNIE readers quote	*T210*
EN readers quote	*240*

Portable Data Loggers

Temperature & RH Recorders

Escort Juniors are low cost, self contained electronic temperature and humidity recorders for industry, climate monitoring, perishables transport and storage.

The Escort Junior range of temperature and humidity recorders are your insurance that the goods and services you provide meet necessary specifications.

They are available in three versions with either internal or external temperature sensors, as well as a model with both humidity and temperature sensors.

Data is securely recorded in non volatile memory which remains available for downloading even in the event of battery failure or removal. The lithium battery has a typical two year service life.

The Juniors record in real time and can be programmed to start on demand by magnet swipe or with a specific date and time wake up. The electronics are housed in a robust ABS plastic case which fits easily into the **Reader Interface** for serial data transfer to a PC.

Alternatively, the battery powered **Escort Junior Chart Reader** allows fast and convenient "on site" downloading of data in graph or over/under specification list form in those situations where PC's are not available.

Tech Innovators

AEE readers quote	*8111*
WNIE readers quote	*T211*
EN readers quote	*241*

E.&O.E. Prices and specifications subject to change without notice. All prices quoted exclude sales tax.

chip data RAM

Other features of the DSP56L811 include: 2.7-3.6Vdc operation plus WAIT and multiple STOP modes; computer operating properly (COP) plus RTI timers; hardware DO and REP loops; three programmable timers; synchronous serial interface (SSI) supports Asynch and Synch Network mode using frame synch and up to 32 time slots; 1k x 16 program RAM, 2K x 16 X-data RAM; controller style addressing modes and instructions; 20 MIPS at 40Mhz in a 100 pin TQFP package. [841](3946)

ENTER 2802 ON CARD

DSP core targeted for microcontroller markets.

Zilog has unveiled its Z893X3 family, available from R&D Electronics, which offers a cost-effective DSP-based alternative to embedded controllers traditionally used in credit card readers, Caller ID, motor control, security systems and telephony applications.

The 20MIPS 16-bit Z893X3 family features powerful on-chip peripherals to simplify product development and reduce system costs. The 4-channel, 8-bit A/D converts analogue to digital signals, the SPI (serial peripheral interface) minimises pin count, two watch-dog timers provide system recovery, 40 I/O lines support many types of application requirements, and a PLL (phased-lock loop) driven clock reduces power consumption.

To support a wide variety of development needs, the Z893X3 family features the cost-effective Z89323 with 8Kwords of ROM and the Z89373, an one time programmable version for prototypes and early production builds. For systems requiring more than 8K words of program memory, the Z89393 family member can address up to 64K words of external pro gram memory.

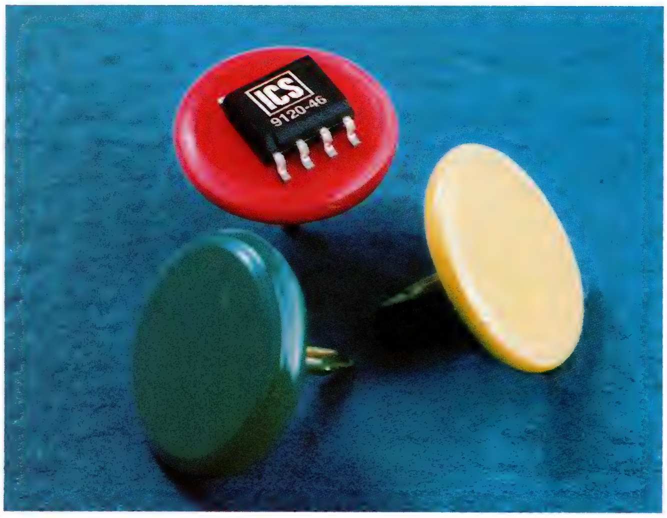
The Z893X3 DSP family is source and object code compatible with the existing Z89321/371/391 devices, providing designers an easy migration path from one DSP family to the next. [841](70)

ENTER 2803 ON CARD

CD-ROM drive upgrades

Three new devices from Zatek Australia allow designers to easily upgrade CD-ROM drives from 4X to 6X and 8X systems. The ICS9120-47/48/49 frequency generators or, clock chips, offer backward compatibility and the flexibility to match different DSP frequencies.

Three chips feature four pre-programmed frequencies to reduce component count, while providing all clock requirements for CD-ROM drive applications. These include the 16.9344MHz microcontroller, 22.5792MHz interface controller, and the 33.8688MHz data decoder. The 9120-47 includes a 50.8032MHz DSP clock; the 9120-48 includes the 42.336MHz DSP clock; and the 9120-49 chip includes frequency generation for a 67.7376MHz DSP clock.



Besides CD-ROM drives, the chips can be implemented in other high-performance multimedia audio drives because they provide the necessary 33.8MHz clock required by such popular sound synthesiser chips such as the Yamaha OPI 3, OPL4, ICS2002. The chips also provide 24.6Hz and 16.9Hz clocks required by many CODECs.

The devices feature the high accuracy and low jitter — ±85ps 1 sigma — characteristic of ICS clock chips. The low-jitter PLLs meet the 150ppm frequency tolerance required by CD-ROM drives and multimedia applications targeted by the chips. [841](8897)

ENTER 2804 ON CARD

First Flash combo chip announced

Atmel Corporation has announced what it claims is the industry's first IC that combines two different memory functions on a single chip and has the ability to do both read and write functions at the same time. Available from GEC Electronics, the device is currently being sampled to potential customers.

The AT29C432, registered as the Concurrent Flash, integrates a 4-megabit Flash memory and a 256Kbit parallel EEPROM to provide concurrent read while writing capability. The device is available in 5V as well as 2.7V versions and operates from a single supply voltage for both read and write functions.

The 4 megabit Flash portion of the Concurrent Flash is configured as a 512K by 8 bit array, containing 2048 individually-reprogrammable sectors of 256-bytes each. The device has a read access time of 120ns and a maximum sector rewrite time of 10ms. A separate erase cycle prior to writing is not required.

The EEPROM portion of the AT29C432 is configured as a 32K by 8 bit array with byte or page (16-bytes per page) write capability. For high endurance, internal error detection and correction (ECC) has been incorporated into the design. Like the Flash array, the maximum write cycle time is 10ms and the read access time of the EEPROM array is 120ns.

The Concurrent Flash uses the same voltage to read and write for both the Flash and EEPROM arrays. [841](13121)

ENTER 2805 ON CARD

Surface-mount Darlington for high gain current drives

The FZT603 Darlington from Zetex, available through GEC Electronics, offers useful forward current gain well up to 6A and a continuous collector current capability of 2A.

Available as an E-Line packaged device, this SOT223 Darlington is to use in automotive, telecomm and instrumentation equipment, and suits relay, solenoid and lamp driving duties.

The NPN FZT603 has a minimum h_{FE} figure of 5k for an Ic of 500mA and V_{CE} of 5V — a performance making it suitable as an interface for microcontroller and logic output circuits. With V_{CBO} and V_{CEO} ratings of 100 and 80 volts respectively, the device is comfortable in the higher voltage domain. [842](13121)

ENTER 2806 ON CARD

Regulator has low 30mV dropout voltage

The ZLDO low-dropout regulator from Zetex, available from GEC Electronics, features 30mV dropout voltage for an output current of 100mA. Three versions provide fixed output voltages of 3.3V, 4.85V and 5V.

The ZLDO has a sensing circuit that monitors input voltage, warning of low battery output should the input voltage fall to within 300mV of the regulated output voltage. The regulator has been optimised for low quiescent current, typically 600µA, for a load current of up to 300mA.

The chip includes a sleep mode. Driving the device's shutdown control input with microprocessor logic places the device in sleep mode, drawing only 11µA. [841](13121)

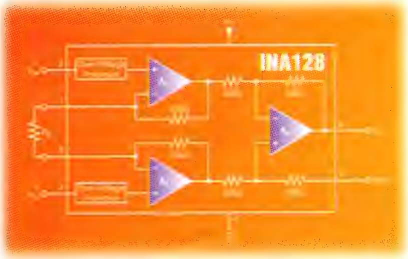
ENTER 2807 ON CARD

Serial peripheral interface (SPI) EEPROM portfolio

National Semiconductor has announced three new Serial Peripheral Interface (SPI) devices, available through Avnet VSI. The NM25C020, NM25C040, and NM25C160 were designed to optimise microcontroller performance in applications needing nonvolatile storage.

National's SPI EEPROM family solves the speed constraints that arise from faster microcontrollers. Existing EEPROM memories require several NoOP (no operation) instructions in the microcontroller's program, which waste cycles while interfacing with the EEPROM. National's EEPROMs require fewer NoOP instructions, allowing more of the performance capability of the microcontroller to be used for code execution.

These new devices offer data transfer rates of 2.1MHz and operate from 2.7V to 5.5V with standby and operating current of 50µA and 3mA respectively. They guarantee typical endurance of one-million cycles and have data retention capability in excess of 40 years. National's SPI EEPROM family offers both hardware and software write protection. Device programming is self-

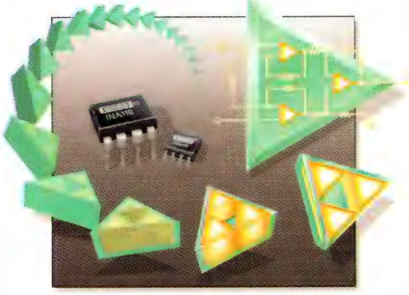


Single & Dual Precision Low Power Instrumentation Amps

INA128 and **INA141** are low power, general purpose instrumentation amplifiers offering excellent accuracy and wide bandwidth—even at high gain (200kHz at G=100). A versatile 3-op amp current-feedback design, small size, and low cost make these amps perfect for a wide range of applications including industrial measurement and control, test and measurement equipment, and medical and scientific instrumentation. Companion **dual** versions, **INA2128** and **INA2141**, save space and lower cost in multi-channel applications.

INA128 key specifications include 50µV max offset voltage, 0.5µV/°C max drift, 5nA max input bias current, 120dB min CMR, and a low 700µA quiescent current. INA141 fixed-gain version provides similar performance and has excellent gain accuracy (±0.05% at G=10).

INA128 and **INA141** are available in 8-pin plastic DIP, SO-8 surface-mount packages; dual versions come in 16-pin plastic DIP and SOL-16 surface-mount packages.



"Power Miser" IA Consumes Only 350µA

INA118 is a precision instrumentation amp ideal for battery powered systems and other low power applications. It's a power miser—operates with power supplies as low as ±1.35V, or single supply operation to 2.7V. Quiescent current is only 350µA. Ideal for portable instruments, thermocouple amplification, medical instrumentation, and general purpose data acquisition designs—available in 8-pin DIP and SO-8 surface mount.

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ENTER 7815 ON CARD

muRata

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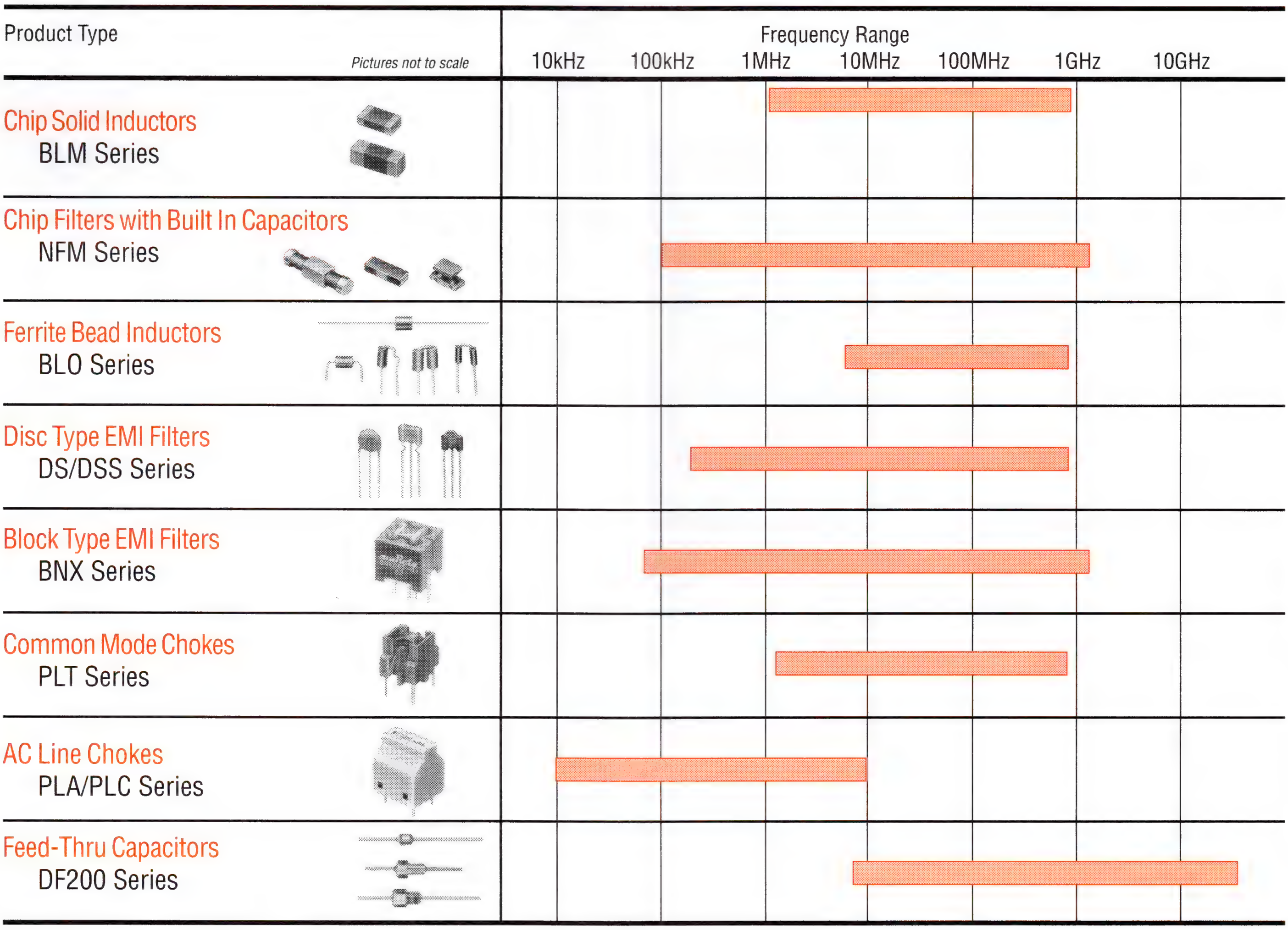

Murata chip technology has won world wide acclaim – for advanced production techniques, for extremely compact construction and for unsurpassed quality. Murata chips have excellent heat and shock resistance. They're washable and they're suitable for both flow and reflow soldering.

In addition to the EMI products illustrated,we can provide a wide range of chip components including –

- ***Monolithic Ceramic Capacitors***
- ***High Frequency Chip Capacitors***
- ***Trimmer Capacitors***
- ***Trimmer Resistors***
- ***Chip Coils***
- ***Chip Filters (AM & FM)***
- ***Chip Ceralock Resonators***

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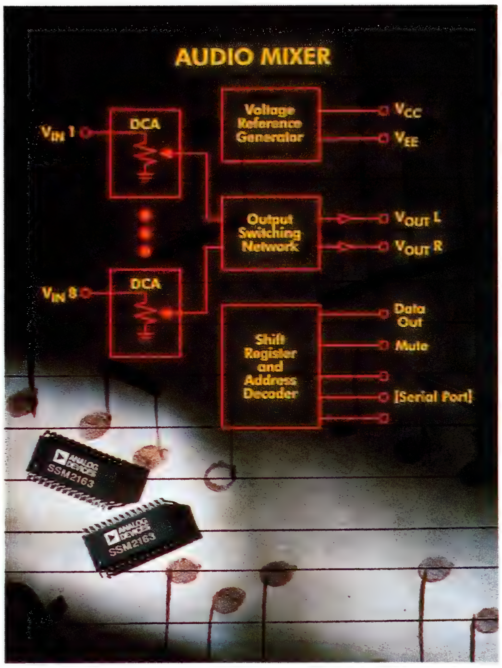
EMI FILTER
CHIP SEMI-VARIABLE RESISTOR
MICROWAVE BANDPASS FILTER
CHIP COIL
CHIP FILTER (AM-FM)
CHIP RESONATOR (CERALOCK®)

ENTER 7816 ON CARD

timed with a maximum of 10 milliseconds. A separate erase cycle is not required before the start of a write cycle. [841](65)

ENTER 2808 ON CARD

Complete 8x2 audio mixer-on-a-chip



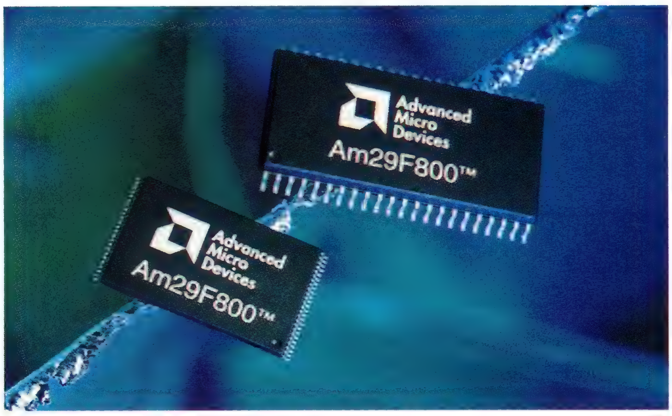
Analog Devices' SSM2163 is a functionally complete 8-input audio mixer-on-a-chip, available from Hartec. It accepts eight audio channels, provides user-friendly control of volume in 63 1dB steps, and can mix individual channels to either the right, left, or both outputs. It replaces multi chip solutions in computer audio systems and improves audio fidelity. The SSM2163 also employs an industry-standard three-wire serial interface and one data output terminal to daisy chain multiple SSM2163s for high-end multi-track audio systems. A single mute pin, when driven by a microprocessor reset signal, will silence all eight audio channels simultaneously. No additional external components are needed for fully specified operation.

Signal-to-Noise is -82dBu (0dBu = 0.775Vrms), with an additional 10dBu of headroom, resulting in a total harmonic dynamic range of 92dBu. Total harmonic distortion plus noise is only 0.007% at 1kHz with all levels set for unity gain. This mixer-on-a-chip can be powered by a single (+5V to +14V) supply or dual (+4V to +14V) supplies.

The SSM2163 is suited for automating many computer audio systems, from high-end multimedia workstations to low-cost PC sound cards. Other applications include professional audio mixing consoles, broadcast equipment, intercom and paging systems, and musical instruments. [841](7327)

ENTER 2809 ON CARD

Eight megabit Flash



AMD has expanded its 5.0 Volt-only Flash offerings with the Am29F800, an 8Mbit device that fills out the Am29Fxxx family, already available in densities ranging from 1 to 16Mbits. The Am29F80, available from Avnet VSI, targets emerging applications such as digital TV set-top boxes, network laser printers and other telecommunication applications.

AMD's single power supply Am29F800 is a 5.0 volt-only 8Mbit flash memory device configured as 512K by 16bits or 1M by 8bits. The use of 5.0V only operation eliminates the need for a 12.0 Volt power supply, which reduces system cost and simplifies board layout.

AMD's Embedded Program and Embedded Erase algorithms simplify flash operation by automating the erase and program operations on the chip, thereby improving system-level performance by freeing the host CPU from dedicated control of the device. Embedded algorithms automatically detect and correct for over-erase and eliminate program/erase software implementation errors associated with first-generation manual algorithm Flash devices. [841](65)

ENTER 2810 ON CARD

Reprogrammable logic device

Cypress Semiconductor has expanded its programmable logic device (PLD) offerings with the introduction of the PALCE20V8, a Flash erasable and reprogrammable device which is pin and functionally compatible with Generic Array Logic products and is available from Braemac.

The device is available in QSOP (Quarter-size Small Outline Packages) packaging, a feature of Cypress's line of standard programmable logic devices. The QSOP package, which measures only 150mil wide with a 25mil pitch, reduces board space by 65% when compared to PLCC packaging. It also reduces ground bounce significantly due to the lower ground lead inductance — approximately 20% of the ground bounce for PDIP packages.

The product has a user-programmable macrocell which includes output polarity control and enables the device to function as a superset to familiar 24-pin PLDs. [841](4274)

ENTER 2811 ON CARD

SHARC attacks DSP market

ICD has available Analog Devices' ADSP-21062 SHARC digital signal processor (DSP). The 32-bit device features 2M of dual-ported SRAM on-chip. Fabricated in a high-speed, low-power CMOS process, the chip has a 25ns instruction cycle time and operates at 40MIPS.

Features of the device include: Super Harvard Architecture — four buses allow dual data fetch, instruction fetch and nonintrusive I/O; 25ns instruction rate, 40MIPS, 120MFLOPS; 32-bit floating point DSP core; up to 4M on-chip SRAM which is dual ported for independent core and I/O access; scalable multiprocessing — glueless connection for cluster and mesh multiprocessing; six link ports for interprocessor communication and array multiprocessing; 10-channel DMA controller; host processor interface that supports 16 and 32-bit microprocessor; two 40Mb/s serial ports; and a 240-lead thermally enhanced PQFP package.

The ADSP-2106x family is supported with a complete set of software and hardware development tools, including EZ-LAB Development Board, EZ-ICE In-Circuit Emulator, and development software. [841](13234)

ENTER 2836 ON CARD

SRAM for fast 3-D graphics

Micron Technology, represented by Reptechnic, has released its MT41LC256K32D4 8Meg SRAM, which includes both standard Synchronous DRAM (SDRAM) in a 256Kx32 configuration, and additional graphics features for improving 3-D graphics performance.

The JEDEC-standard device in also called a Synchronous Graphics RAM (SGRAM) because it includes both the standard SDRAM features plus additional graphics features.

The device comes in a 100-pin TQFP package and is designed to operate in 3.3V, low-power memory systems. With JEDEC-standard features such as 8-column block write and write-per-bit modes, dual bank, pipelined architecture and programmable burst lengths of 1, 2, 4, 8 or full-page, Micron's 8Meg SGRAM will fully support the higher bandwidth requirements and faster display refresh rates required by sophisticated graphics applications. [841](155)

ENTER 2837 ON CARD

Scalable encoder chipset for video comms

Braemac has available IBM's MPEGME30, a full-function IPB encoder chipset, comprising an I-frame (MPEGSE10), a refine (MPEGSE20), and a search (MPEGSE30). The three-chip encoder is a scalable chipset that operates in three different configurations: the I-frame; I-frame and refine; and I-frame, refine and search.

The single I chip is an I-frame only video encoder. It supports full-motion video up to CCIR 601 resolution for NTSC and PAL. Picture expansion is provided with an additional 16 lines of vertical scan. The chip supports 4:2:2 chroma encoding.

Potential applications include video conferencing, video editing/authoring, and surveillance/security. Expansion is possible with the addition of the refine chip for IP encoding. Adding the search ship provides complete IPB encoding. [841](4274)

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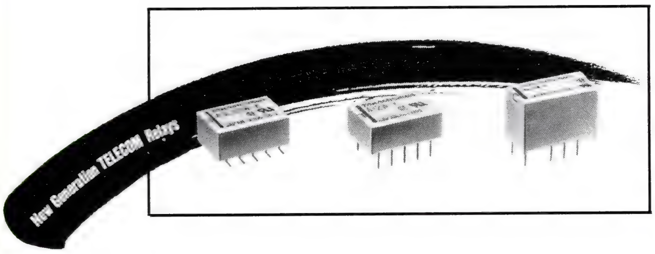

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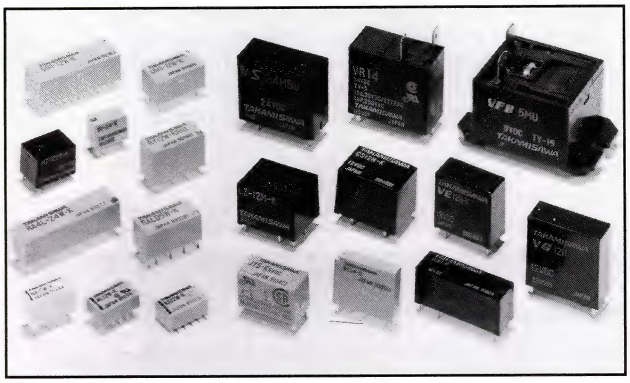

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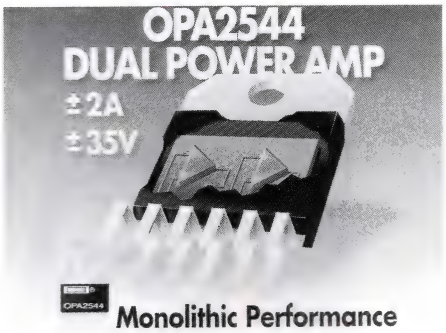


The Burr-Brown OPA2544, available from Kenelec, is a dual high-voltage, high-current operational amplifier suitable for driving a wide variety of high-power loads. It provides output of 2A and its power supply extends to ±35V.

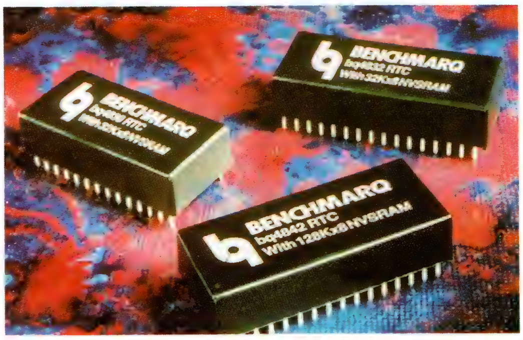
The unit is designed to drive a wide range of electromechanical devices, including motors, valves and speakers. It is also suitable for power supplies and automated test equipment.

The OPA2544 integrates two high-performance FET-input op amps with high-power output stages on a single monolithic chip. Its internal current limit and thermal shutdown protect the amplifier from damage.

Other key specifications include: 2A output current, 8V/µs slew rate, 50pA input bias current, internal current limit and thermal shutdown protection. [841](4)

ENTER 2812 ON CARD

Real-time clock with on-board memory



Reptechnic has available from Benchmarq several Real-Time Clock modules, which combine RTC functions, CPU supervisor and non-volatile SRAM in one package.

The bq4830 provides non-volatile SRAM by combining an internal lithium battery with a 32Kx8 SRAM, a quartz crystal clock and power-fail chip. This provides a minimum 10-year data retention and unlimited write cycles.

Also available are the bq4832 and bq4842, which provide the same features as the bq4830, with the addition of full CPU supervision. The bq4832 provides a watchdog timer, power-on reset, alarm/period interrupt, power-fail and low-battery warning, along with the low-power RTC and SRAM. The bq4842 is pin-compatible with the bq4832, but with a 128K non-volatile SRAM.

The units are suitable for use in applications such as POS terminals, controllers, copiers, and PBX systems. [841](155)

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For Literature, Call Vishay's FlashFax℠ Service at 0011-1-402-562-6729.
(For specific document numbers, refer to the articles below.)

Sprague® Provides Low ESR Capacitors for Pentium™ Applications

Solid Tantalum Chip Capacitors Solve Filtering Problems

The newest Pentium microprocessors are pushing power supply designers to use low equivalent series resistance (ESR) capacitors to control ripple current and ripple voltages. Other factors including power dissipation capabilities, lower voltages, miniaturization, surface mount assembly and operating frequencies also affect the designer's selection of filter capacitors.

For frequency filtering below 500kHz, Sprague's 594D tantalum chip capacitor offers the best combination of low ESR, good power dissipation, and small SMD construction compared to other technologies.

Like all solid tantalum chip capacitors, the 594D is extremely stable under temperature changes and time. In addition, they have no end-of-life constraints or known wearout mechanisms for excellent reliability and stability.

The 594D features values ranging from 4.7µF to 470µF and voltages from 4V to 50V. For space critical applications, the conformally coated 594D offers up to 35% better volumetric efficiency than a molded chip at the same rating.

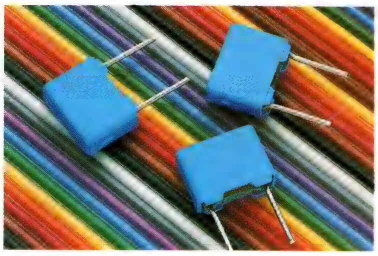
For a data sheet, call Vishay's FlashFax℠ Service at 0011-1-402-562-6729. Document #518.

Pentium™ is a trademark of the Intel Corporation.

Roederstein Introduces a New Miniature Film Capacitor

The Highest C-values Available with 5mm Lead Spacing

Roederstein Electronics, Inc. has expanded its MKP 1840 series of metallized polypropylene film capacitors to include a new miniaturized version with the highest C-values available with 5mm lead spacing. Fully auto-insertable, these capacitors allow the design engineer to take advantage of a much reduced printed circuit board footprint while maintaining the superior characteristics of the polypropylene dielectric.



Polypropylene's excellent stability, very low dielectric absorption, high insulation resistance and low dissipation factor make these capacitors ideally suited for use in designs where precision is required, such as audio and instrumentation applications. Most commonly these capacitors are used in oscillators, timing and LC/RC filter circuits, high frequency coupling/decoupling, cross-over networks, and sample and hold circuits.

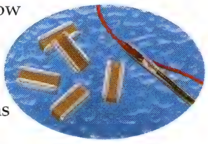
Roederstein's MKP 1840 capacitors are also self-healing and do not exhibit a piezio-electric effect. The new 5mm lead-space capacitors are available in C-values up to .10µF and in a 100-volt rating. Larger sized capacitors are available in higher voltages and capacitance values up to 10µF. All are encapsulated in flame-retardant cases.

For a data sheet, call Vishay's FlashFax℠ Service at 0011-1-402-562-6729. Document #707.

Low Inductance Capacitor from Vitramon® Improves Circuit Performance

0612 Cuts Inductance in Half

Selecting capacitors with low inherent inductance is always an important design consideration—particularly in high speed microprocessor and multi-chip module circuitry. Normally in the 0.8nH to 1.0nH range, this inductance can now be cut by more than half with a new monolithic ceramic chip capacitor developed by Vitramon®.



The new Vitramon chip (VJ0612) provides standard inductance levels as low as 0.3nH in easily-packaged dimensions (.062"L x .126"W x .038"H). Standard capacitance range is from 8200pF to 0.22µF with tolerances of ± 5%, ± 10%, ± 20% and voltage ratings of 25V and 50V.

This combination—available in a robust, easily mounted package—makes the VJ0612 ideal for use in new designs where low inductance is important as well as for improving the performance of existing circuitry.

For a data sheet, call Vishay's FlashFax℠ Service at 0011-1-402-562-6729. Document #410.

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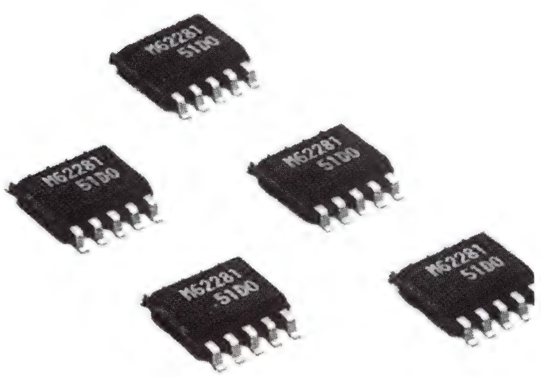
Versatile PWM control IC



Available from Adilam is the M62213 pulse width modulator (PWM) IC, which incorporates many functions in a small 10-pin package for use in developing standard switching power supply The IC is equipped with a high-speed PWM comparator and current limit circuit and conducts switching at speeds as high as 700kHz. Despite its small size, the unit can be used to design a full-scale switching power supply with a minimum of external components. [841](25)

ENTER 2814 ON CARD

IF transceiver

Analog Devices has added the AD6432 3V transceiver to its range of RF/IF products, available from Hartec. This monolithic device has all the building blocks needed for modulation and demodulation of signals for digital wireless systems and replaces a dozen or more discrete components. It can be used by itself for low-power systems up to 300MHz RF carrier frequencies, or with RF up-and-down-converters for higher carrier frequencies. The I/Q modulation and demodulation method enables the chip to be used with the modulation formats most commonly used in digital wireless systems, including GMSK, QPSK, DQPSK, and spread-spectrum systems.

The receive section accepts input signals up to 300MHz, down-converts to a user-selected IF (intermediate frequency) between 10 and 30MHz, provides gain from –20 to +60dB, and provides baseband I and Q (In-phase and Quadrature) output signals with up to 8MHz bandwidth. The gain is controlled by an analogue control voltage with linear-in-dB voltage control. Input 1dB compression point is –15dBm, and the minimum input signal level is –90dBm for 3dB S/N at the output. The quadrature demodulator provides ±1.5 degree phase accuracy.

The transmit section includes I/Q modulators and summing amplifier, accepting modulation bandwidths up to 1MHz and modulating a carrier frequency up to 300MHz. The output level is nominally –50dBm and can drive an up-converter to a higher carrier frequency or a power amplifier. [841](7327) **ENTER 2815 ON CARD**

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10 Exporters
10 R&D Companies
10 Revenue per employee
10 Revenue improvers

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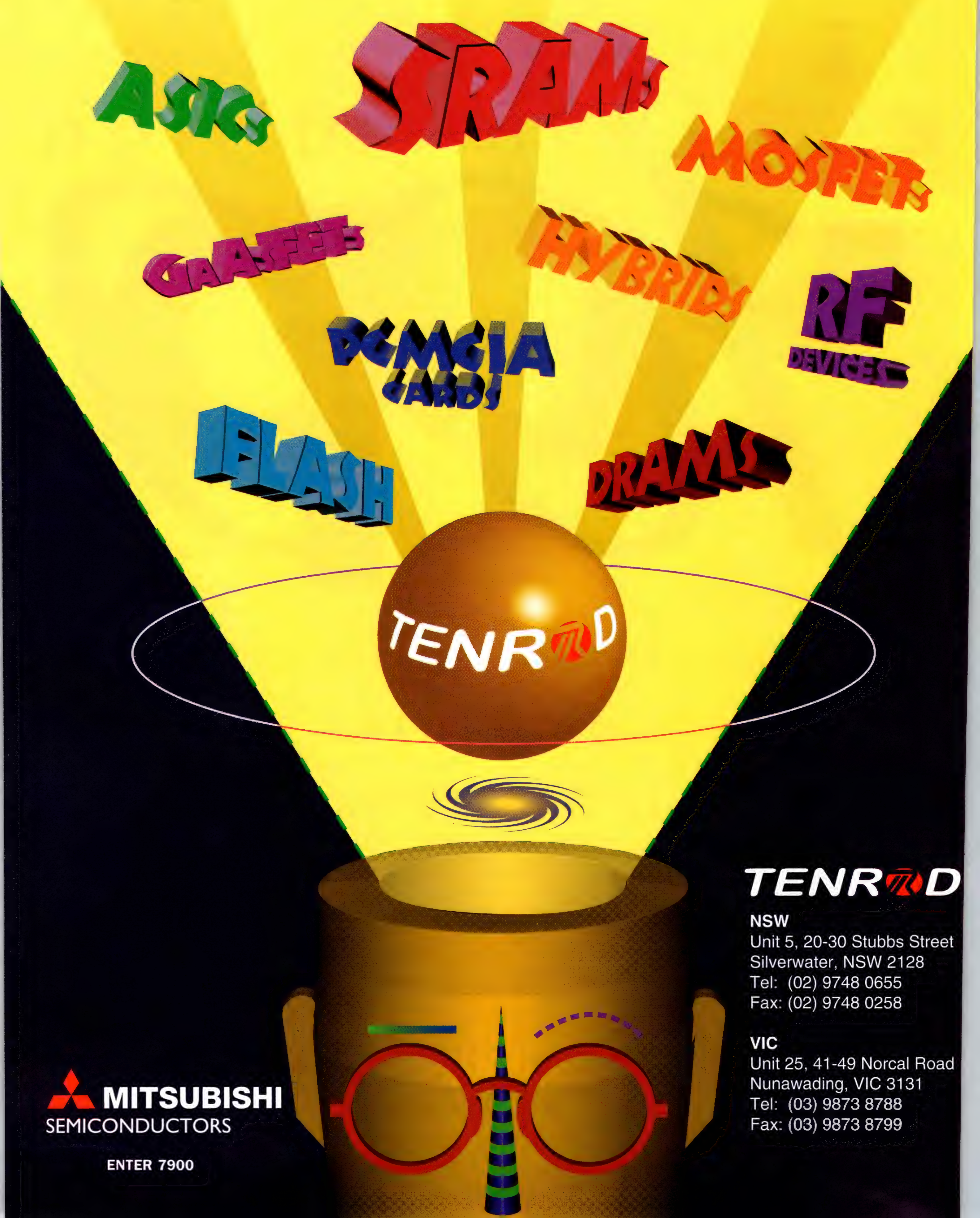

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Top 100 Electronics Companies in Australia

The electronics industry in Australia is a broad and far-reaching one. This country has often been looked on as a gateway to the Asia-Pacific region, with many US and European multinationals positioning their Asia-Pacific headquarters here. The reasons for this are that Australia provides a western culture on the Asia-Pacific doorstep, and we have a long history of innovation and acceptance of new technologies. As well, Australia provides a great depth of local engineering talent.

Over the last decade the Australian electronics industry has matured and developed, and today we are world-competitive on a number of fronts — telecommunications and software design are notable examples.

Recently *AEE* conducted a survey to find out just how much electronics business was being done in this country, and the results are detailed in this special supplement.

About the figures

AEE used several sources to obtain the company details shown. Most of the information came from survey forms returned by the companies. We'd like to thank all those companies who helped us out in this regard.

Other sources of information were the Australian Securities Commission (ASC), the Financial Review and other financial publications, and company press releases and other public information.

In cases where no direct figures for a company's last financial year were available, we've estimated the revenue based on information from a number of sources. In such cases we've marked the revenue entry in the tables as *AEE estimate only*.

The Top 100

The total gross revenue of the Top 100 exceeded $8 billion, with the top 10 companies representing around $5.5 billion or 70% of the total revenue. A common rule-of-thumb says that usually in an industry the top 10% of companies make 90% of the revenue. If that's true, the electronics industry is a little more evenly spread than most. Ericsson topped the star-studded field with a revenue of $800 million (excluding mobile phone sales), closely followed by Fujitsu Australia and Alcatel. The top-ranked Australian-owned company was AWA which, despite its recent restructuring and change of direction, managed to turn over a respectable $314 million in its last financial year.

Not surprisingly, a lion's share of the top 100 positions was occupied by companies working in the telecommunications sector, or those supporting it.

Telecommunications has provided the major focus for electronics in Australia over the last few years, and has stepped into the role once occupied by the defence industries — the industry driver and innovator. Almost all of the top companies listed have some involvement in telecommunications.

Top 10 exporters

Once again telecommunications companies figured prominently when it came to exports. We asked companies to give us their export revenue as a percentage of total sales revenue and we've listed the top 10 companies based on gross export dollars in the table (*Top 10 companies — Export revenue*) on page T5.

Alcatel Australia came out on top, citing a huge $222 million (30% of its gross sales revenue) earned from exports. Alcatel has a heavy involvement in building international telecommunications infrastructure systems, such as undersea fibre-optic cable links, the cable for which is manufactured at Alcatel TCC's

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TOP 100

Top 100 Electronics Companies in Australia

RANKED BY GROSS ELECTRONICS SALES REVENUE

Ranking	Company	Electronics Sales Revenue
1	Ericsson Australia	$800,000,000
2	Fujitsu Australia	$755,000,000
3	Alcatel Australia	$740,000,000
4	Pacific Dunlop Cables Group	$675,000,000 (AEE estimate only)
5	Hewlett-Packard Australia	$634,000,000
6	Philips Electronics Australia	$484,000,000
7	Siemens	$419,000,000 (includes NZ)
8	Motorola Australia	$383,128,000 (ASC data - sales revenue)
9	AWA	$314,477,000 (ASC data - consolidated sales revenue)
10	James Hardie Building Services	$312,700,000
11	Datacraft	$194,000,000
12	HarTec	$137,939,000
13	ERG	$130,000,000
14	Cisco Systems	$110,000,000 (company estimate)
15	Intel Australia	over $100,000,000 (AEE estimate only)
16	British Aerospace Australia - Electronic Systems GP	over $100,000,000 (company estimate)
17	Hypertec	$87,203,183
18	Keycorp	$80,000,000
19	Arlec Australia	$75,600,000
20	Nortel Australia	$75,283,000
21	JNA Telecommunications	$66,979,000 (ASC data - consolidated sales revenue)
22	Honeywell	$60,000,000 (unaudited)
23	IBM (Wangaratta Manufacturing Services)	$60,000,000
24	Avnet EMG (Australia)	$51,000,000
25	CelsiusTech Australia	$50,000,000
26	Andrew Australia	$45,000,000
27	Scitec	$42,151,000
28	Allen-Bradley	$40,777,771 (ASC data - company sales revenue)
29	Hawker Batteries	$40,000,000 (AEE estimate only)
30	Codan	$39,000,000
31	Jtec	$38,000,000
32	Cray Communications	$36,352,000 (ASC data - parent company sales revenue)
33	NetComm	$34,000,000
34	GEC Plessey Telecommunications (Australia)	$33,023,000
35	University Paton	$32,293,000 (ASC data - sales revenue)
36	Braemac	$30,100,000
37	GEC Electronics Division	Not for publication
38	Crystalaid Manufacture	$24,000,000
39	Farnell Electronic Components	$23,932,000 (ASC data - consolidated sales revenue)
40	Mitec	$21,000,000
41	Wormald Technology	$20,000,000
42	Tektronix Australia	$20,000,000
43	Huber + Suhner Australia	$20,000,000 (AEE estimate only)
44	Omron Electronics	$19,320,900
45	AC&E	$18,500,000
46	Australian Electronic Manufacturing Services	$18,100,000
47	TechComm Group	$16,610,000
48	Australian Arrow	$16,500,000
49	Tech-Rentals	$16,383,571
50	QPSX Communications	$15,000,000
51	Mayer Krieg	$15,000,000
52	Racal Australia	$15,000,000
53	Global Lightning Technologies	$14,600,000
54	IRH Components	$13,200,000
55	Morris Productions	$13,200,000 (AEE estimate only)
56	SAGEM Australasia	$12,632,000
57	Fibernet	Not for publication
58	Wandel & Goltermann	Not for publication
59	Adilam Electronics	$11,800,000
60	Nilsen Instruments	$11,227,438 (ASC data - sales revenue)
61	Rohde & Schwarz (Australia)	$11,000,000
62	Nilsen Industrial	$10,500,000 (AEE estimate only)
63	Vision Systems	$9,702,000 (ASC data - operating revenue)
64	Amtron Australia	$9,500,000
65	Pacific Communications	$9,337,622
66	Artronic Productions Australia	$9,000,000
67	Scientific Devices Australia	Not for publication
68	Utilux	Not for publication
69	Precision Circuits	$8,638,955 (ASC data - sales revenue)
70	PC Assemblies	$8,500,000
71	Skandia Electronics	$8,354,000
72	Protel International	$8,000,000
73	Communitron (Aust)	$7,600,000
74	Crusader Electronics	Not for publication
75	Signalling Technology	Not for publication
76	R&D Electronics	$6,200,000
77	Powerbox	AEE estimated position only
78	Pepperl & Fuchs (Aust)	$5,500,000
79	Rojone	$5,200,000
80	3M Australia	Not for publication
81	MFB Products	Not for publication
82	Electronic Development Sales	$5,000,000
83	Priority Electronics	$5,000,000
84	VME Systems	Not for publication
85	Richpac Technologies	$4,600,000
86	Data Electronics (Aust)	$4,540,000
87	National Instruments	Not for publication
88	Amtex Electronics	$4,200,000
89	Anton Piller (Australia)	$4,200,000 (unaudited)
90	E S Rubin Group	$4,100,000
91	ICM	$3,800,000
92	Alpha Kilo Services	$3,500,000
93	Kenelec	(AEE estimated position only)

We estimate that the following seven companies will be in the Top 100 rankings list, but we were unable to find enough information to estimate their revenue.

Setec
Tenrod Electronics
Veltek Australia
Aristocrat Leisure Industries
NEC Australia
Entech
Texas Instruments Australia

Top 10 Electronics Companies — Export revenue

Ranking	Company	Exports (as % of revenue)	Exports ($)
1	Alcatel Australia	30.0%	$222,000,000
2	Ericsson Australia	13.0%	$104,000,000
3	ERG	54.0%	$70,200,000
4	Hypertec	50.0%	$43,601,592
5	Keycorp	45.0%	$36,000,000
6	Codan	77.0%	$30,030,000
7	Siemens	7.0%	$29,330,000 (includes NZ)
8	Hartec	18.0%	$24,829,020
9	Andrew Australia	35.0%	$15,750,000
10	Scitec	26.0%	$10,959,260

Top 10 Electronics Companies — R&D expenditure

Ranking	Company	R&D (as a % of revenue)	R&D ($)
1	Ericsson Australia	10.0%	$80,000,000
2	Alcatel Australia	10.0%	$74,000,000
3	Siemens	15.0%	$62,850,000 (includes NZ)
4	Hewlett-Packard Australia	5.0%	$31,700,000
5	ERG	17.0%	$22,100,000
6	Keycorp	16.0%	$12,800,000
7	Jtec	28.0%	$10,640,000
8	Nortel Australia	12.0%	$9,033,960
9	Datacraft	3.3%	$6,402,000
10	Scitec	10.0%	$4,215,100

Top 10 Companies — Revenue per employee

Ranking	Company	Employees	Revenue per employee
1	Cisco Systems	130	$846,154 (company estimate)
2	Hewlett-Packard Australia	800	$792,500
3	Avnet EMG (Australia)	65	$784,615
4	HarTec	200	$689,695
5	Hypertec	131	$665,673
6	Braemac	46	$654,348
7	Datacraft	330	$587,879
8	Fujitsu Australia	1333	$566,392
9	Rohde & Schwarz (Australia)	20	$550,000
10	CelsiusTech Australia	95	$526,316

Top 10 Companies — Increased sales revenue

Ranking	Company	Sales revenue increase over previous year
1	Cisco Systems	100.0%
2	Priority Electronics	100.0%
3	Keycorp	86.0%
4	Hypertec	79.9%
5	PC Assemblies	77.1%
6	E S Rubin Group	70.8%
7	JNA Telecommunications	69.5%
8	Australian Arrow	65.0%
9	Australian Electronic Manufacturing Services	53.8%
10	Crystalaid Manufacture	50.0%

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Core business: Component distribution/sales, electronic interconnect components and assemblies
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned: No, US public listed
Key executives: Harold Lasken, Managing Director
John Maclay, General Manager
David Stanton, Sales & Marketing Manager
Profile: 3M markets a wide variety of products to medical, pharmaceutical, dental, traffic, safety, industrial, consumer and office markets. Products are as diverse as pressure-sensitive tapes, abrasives, protective chemicals, fibre optic and copper-cable connecting systems.

AC&E

See enhanced listing on page T12.

Adilam Electronics

See enhanced listing on page T10.

Alcatel Australia

280 Botany Road,
Alexandria NSW 2015
Phone: (02) 9690 5155
Fax: (02) 9690 5111
Branches: ACT, NSW, QLD, SA, WA, VIC
Core business: Electronics manufacturing
Gross electronics sales revenue: $740,000,000
R&D (as a percentage of revenue): 10.0%
Exports (as a percentage of sales): 30.0%
Employees: 2400
Australian owned: No, private
Key executives: Ron Spithill, Managing Director
Profile: Alcatel Australia is one of the leading designers, manufacturers and exporters of advanced communications systems for markets both at home and overseas.

Allen-Bradley

37 Chapman St,
Blackburn VIC 3130
Phone: (03) 9899 0335
Fax: (03) 9890 0953
Branches:
Core business: Programmable control & electrical control distributor
Gross electronics sales revenue: $40,777,771 (ASC data - company sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 50-99
Australian owned: No, owned by Rockwell International
Key executives:
Profile: Demand for the company's products continued to improve during the year and the introduction of a number of new products has extended the company's market base.

Alpha Kilo Services

7/12-18 Clarendon St,
Artarmon NSW 2064
Phone: (02) 9901 3770
Fax: (02) 9901 3774
Branches: NSW, VIC
Core business: Component distribution/sales
Gross electronics sales revenue: $3,500,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 18.0%
Employees: 12
Australian owned: Yes, private
Key executives: Derek King, Managing Director
Profile: No information supplied.

Amtex Electronics

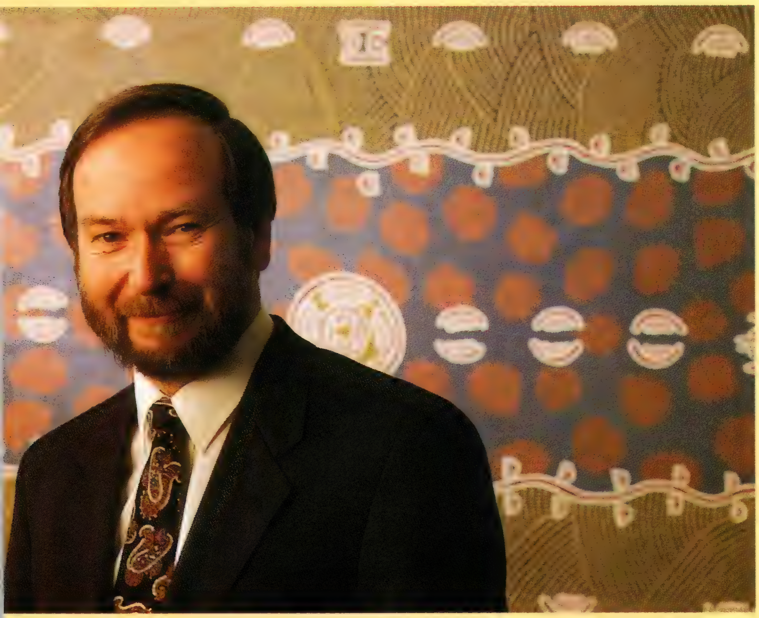
13 Avon Road,
North Ryde NSW 2113
Phone: (02) 9805 0844
Fax: (02) 9805 0750
Branches: VIC
Core business: Component distribution/sales
Gross electronics sales revenue: $4,200,000
R&D (as a percentage of revenue): 1.0%
Exports (as a percentage of sales): 4.0%
Employees: 13
Australian owned: Yes, private company owned by employees
Key executives: James Kuswadi, General Manager;
Peter McBride, Sales Manager/Displays & systems
Peter Mitso, Sales Manager/Power supplies
Mark Malik, Administration Manager
Profile: Importer & distributor of high-tech electronics and custom solutions. Major contracts with Telstra, NEC, AWA, Honeywell. Its strength is its people: technically qualified, reliable and committed to serving customers.

Amtron Australia

687 Gardeners Rd,
Mascot NSW 2020
Phone: (02) 9317 5511
Fax: (02) 9669 6216
Branches: WA, VIC
Core business: Electronics manufacturing, component distribution/sales, communications
Gross electronics sales revenue: $9,500,000
R&D (as a percentage of revenue): 7.5%
Exports (as a percentage of sales): 15.0%
Employees: 52
Australian owned: Yes, private
Key executives: Robert Hastings, Managing Director
Paul Deluka, National Sales Manager
Maureen Phinn, Financial Controller
Profile: Amtron Australia is a major manufacturer of connectors for use in the telecommunications industry. Amtron won a tender to supply D subminiature connectors to Telstra for the next 5 years. An office has also been opened in Beijing, China.

Andrew Australia

153 Barry Rd,
Campbellfield VIC 3061
Phone: (03) 9357 9111
Fax: (03) 9357 9110
Branches:
Core business: Antennas, cables etc for telecommunications systems
Gross electronics sales revenue: $45,000,000
R&D (as a percentage of revenue): 3.0%
Exports (as a percentage of sales): 35.0%
Employees: 108
Australian owned: No, division of Andrew Corp., US
Key executives: John Saunderson, Operations Manager and CEO
Barry Greig, Financial Officer
Brendan Millard, Area Sales Manager
Gary Cox, Manufacturing Manager
Warwick Armstrong, Principal Engineer
Profile: Andrew Australia is a major supplier of antennas and cables to Australian organisations such as Telstra, Optus and Vodafone, and to similar organisations in New Zealand, Papua New Guinea, Pacific rim and South East Asian countries.



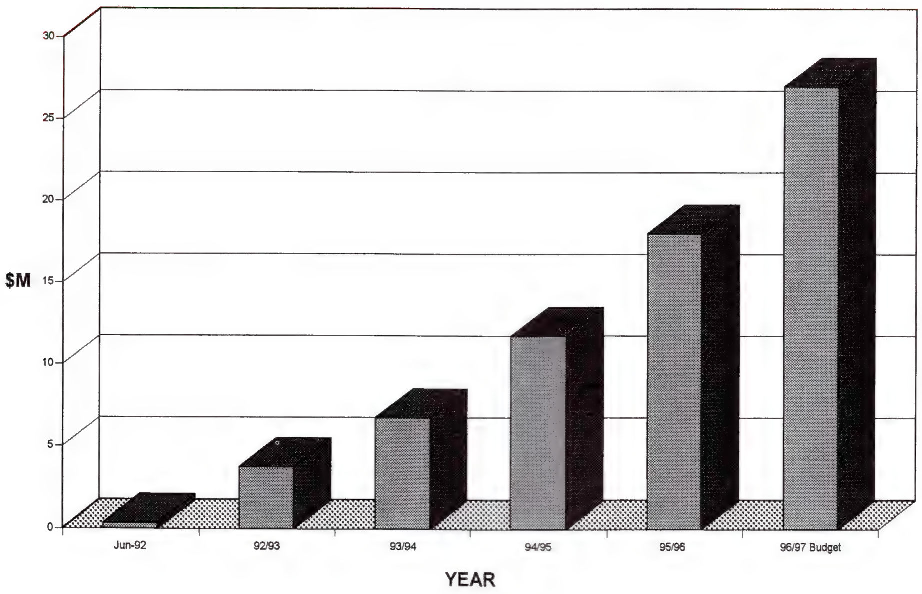
Australian Electronic Manufacturing Services (AEMS)

Head office: Unit 47, Slough Business Estate, Slough Avenue,
Silverwater Sydney NSW 2128
Phone: (02) 9748 6626
Fax: (02) 9748 7065
Branch: Melbourne
Core Business: Contract Electronic Manufacturing
Gross electronic sales revenue: $18 million
R&D: (as a percentage of revenue):Nil
Exports (as a percentage of sales): No direct sales
No. of Employees: 240
Key executives: Hugh Kelly, Andrew Lovett, Teresa Tolley, Neil Boyle.

Profile: Founded in 1992, Australian Electronic Manufacturing Services (AEMS) is the rising star on the local contract electronic manufacturing scene.

Formed by a management buyout of GEC Plessey Telecommunications (GPT) employees in March 1992, the company has gone from strength to strength, proving that there is always demand for a contract manufacturing service of consistent quality and reliability.

AEMS SALES BY YEAR



AEMS contract manufactures sophisticated electronic products such as modems and electronic fund transfer point of sale (EFTPOS) terminals, manufacturing about 50 to 60,000 printed circuit boards every month.

The company has also progressed into printed circuit board design, component procurement and the servicing of finished products such as mobile phones.

It prides itself on a consistently high level of service and reliable on-time delivery of product to its customers.

Starting with 17 people in 1992, the forward-thinking company now employs 240 people. Turnover has increased from $3 million to $18 million. And floor area has increased from 800 sq metres to its current 7800 sq metres.

But expansion hasn't stopped there.

The company has already taken the next step towards attaining its goal of becoming Australia's largest contract manufacturer. A new 2300 sq metre facility has just opened in Melbourne, where AEMS plans to compete for the contract business of the major multinational companies.

Realising a vision:

And the company is looking further afield than just Australia for its business. Hugh Kelly, the company's visionary managing director, says his "mission is for AEMS to be the major Australian company in the market, with world competitive facilities both here and in Asia".

It is this vision that has spurred the company's phenomenal growth in its four years' existence.

Major capital investment:

AEMS has invested heavily in capital equipment to offer extensive world class surface mount and through-hole capacity to its broad customer base. Its production capabilities are supported by manufacturing defect analysers and in-circuit test equipment, with functional test carried out on product specific equipment.

Recent additions to its impressive array of machines include a Universal VCD axial machine and a Yamaha vision glue system. Other equipment that will contribute greatly to AEMS's ability to satisfy customers' needs are an MPM A25 screen printer, an SMT hot air split vision rework station and a Heller 1500 forced convection reflow oven.

A people company:

The core of any business is its people. And the 240 employees at AEMS are constantly supported and encouraged to show initiative and take pride in their work. AEMS recognises that it will only remain competitive and continue to meet its customers' needs by being totally committed to maintaining and improving the skills and expertise of all staff.

A structured in-house training plan uses the services of experienced training providers such as TAFE and the Canberra Institute of Technology.

Most of the staff are shareholders in the company – an added incentive for employees to take pride in their performance.

Quality every step of the way:

AEMS was certified to ISO 9002 in September 1993 – a mere 18 months after start-up. The company constantly and consistently places great emphasis on adhering to quality procedures and maintaining traceability in every step of manufacture – from goods received to packaging and despatch. Its MRP II system is based on Impact software running on a Unix network.

Last year the company embarked on a program concentrating on the Australian Quality Awards.

Now firmly embedded in the Australian manufacturing landscape, AEMS plans to continue its unwavering path towards becoming a truly global player.

AEMS

Anton Piller (Australia)

4 Expo Crt,
Mt Waverley VIC 3149
Phone: (03) 9562 8466
Fax: (03) 9562 8850
Branches: NSW, QLD
Core business: UPS, frequency converters supplier
Gross electronics sales revenue: $4,200,000 (unaudited)
R&D (as a percentage of revenue): 1.0%
Exports (as a percentage of sales): 3.0%
Employees: 20
Australian owned: No, private
Key executives: Baden Berry, Managing Director
Herman Rust, Contracts Director
John Hudson, Company Secretary
Jonathon Davis, Regional Sales Manager
Profile: The main activity centres around the supply, installation, testing, commissioning and servicing of uninterruptible power systems and frequency converters. A major contract was the provision of UPS for Cathay Pacific in NSW at a contract price of around $2.6m.

Arlec Australia

Maroondah Hwy, Mooroolbark
VIC 3138
Phone: (03) 9727 8777
Fax: (03) 9727 8555
Branches: NSW, QLD, SA, WA
Core business: Electronics manufacturing, component distribution/sales, communications
Gross electronics sales revenue: $75,600,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 198
Australian owned: Yes, subsidiary of Kalamazoo Ltd, a public listed company
Key executives: Jeffrey Hooper, Managing Director
Terry Lucas, Financial Director
Joseph Telfer, Technical Director
Craig Geddes, Financial Controller
Michael Nimmervoil, Engineering Manager
Peter Angus, Marketing
Profile: Arlec is a manufacturer of transformers, power supplies, PIR equipment and sole Australian distributor for NEC Philips semiconductor and passive components.

Artronic Productions Australia

See enhanced listing page T14.

Australian Arrow

65 Lathams Rd,
Carrum Downs VIC 3201
Phone: (03) 9786 2911
Fax: (03) 9786 2499
Branches: SA
Core business: Electronics manufacturing
Gross electronics sales revenue: $16,500,000
R&D (as a percentage of revenue): 6.5%
Exports (as a percentage of sales):
Employees: 84
Australian owned: No, private
Key executives: D V Smith, Managing Director
M Schuurman, General Manager/Director
F J Griffin, Marketing Manager
C R James, R&D Manager
S A Power, EMD Manufacturing Manager
Profile: Development and supply of Remote Keyless Entry System for 1996 Magna. Development and Supply of CIR (Keyless entry, immobilisation and alarm) system for Toyota Camry and Corolla. Advanced automotive electronics systems (wiring harness, computer system) for motor vehicles.

Australian Electronic Manufacturing Services

See enhanced listing on page T8-9.

Avnet EMG (Australia)

See enhanced listing on page T13.

AWA

15 Talavera Rd,
North Ryde NSW 2113
Phone: (02) 9887 7111
Fax: (02) 9887 7692
Branches:
Core business: Electronics and communications
Gross electronics sales revenue: $314,477,000 (ASC data - consolidated sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned: Yes, public
Key executives: John Dougall, Managing Director
Marie Louise Sexton, Company Secretary
Profile: AWA's activities include defence (missile decoy systems, electronic warfare and surveillance systems); communications (multiplexers and microwave radio systems for rural areas); intelligent road traffic systems; and aerospace (air navigation beacons and

Adilam Electronics Pty Ltd

3 Nicole Close, North Bayswater VIC 3153
Phone: (03) 9761 4466
Fax: (03) 9761 4161
Branches: Sydney, Brisbane, Adelaide, Auckland, Christchurch
Core business: Component distribution/sales
Gross electronics sales revenue: $11.8 million
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 36
Australian owned: Yes, private
Key executives: Keith John Anderson, Managing Director;
Margaret Anderson, Financial Director;
Mark John Anderson, Marketing Director

Robert Gottliebson of BRW, guest speaker at the Victorian Business Awards, with Adilam directors Margaret and Keith Anderson.

Profile: Adilam completed its 12 successive years of increased sales in 1995. The addition of semiconductors over recent years, to the already established lines of passive components, electro-mechanical products and connectors now positions Adilam as one of the leading broadline distributors of electronic components in Australia.

In 1995 Adilam won the Wholesale, Distribution and Allied Industries category of The Age/Dun and Bradstreet Business Who's Who Victorian Business Award.

Early in 1996 the Company was listed in the Top 100 Fastest Growing Private Companies in Australia in a survey featured in the Business Review Weekly in association with Siemens Nixdorf and Price Waterhouse.

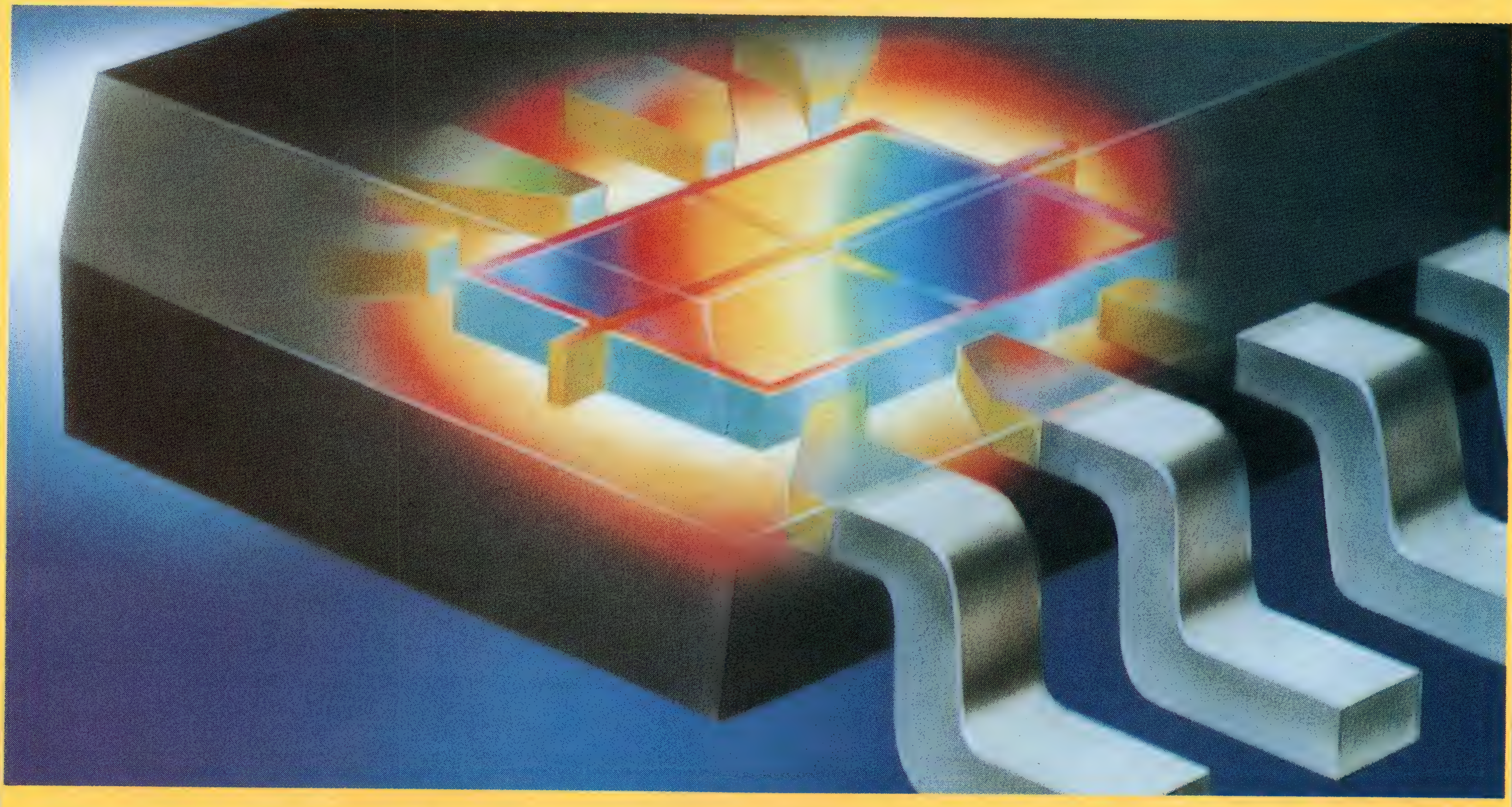
Offices were opened in Auckland and Christchurch New Zealand during 1995, as well as a new branch in Adelaide on the 1st July 1996. In addition, Adilam plans to build a larger head office in Melbourne in 1997.

Adilam Electronics Pty. Ltd.
The Component Specialists

Commenting on the growth of Adilam, Mr Keith Anderson, indicated that continual enhancement of its Quality System. (Adilam has been accredited to ISO 9002 since August 1992), and upgrading of the warehousing and computer systems is assisting in the expected expansion of Adilam in the coming years.

Serial EEPROMs

Guaranteed for 1 million Erase/Write Cycles



No one else has the guts to guarantee 1 million cycles - but then no one else has the technology

BUS	BIT DENSITY								
FC		1K	2K	4K	8K	16K			
XFC						16K	32K	64K	256K
MICROWIRE	256®	1K	2K	4K					
SPI		1K	2K	4K		16K		64K	256K
PARALLEL								64K	256K

- Serial EEPROMs guaranteed for 1 million erase/write cycles over the entire -40 C to+125 C temperature range.
- Each 2.5 to 5.5 low voltage device includes write protection circuitry.
- Choice of DIP or SO packages rated for commercial, industrial and automotive applications

BRAEMAC

SGS-THOMSON
® MICROELECTRONICS

LLOYD'S REGISTER QUALITY STOCKIST ISO9002

NATIONAL ACCREDITATION OF CERTIFICATION BODIES

Sydney
Tel: 02 550 6600
Fax: 02 550 6377

Melbourne
Tel: 03 540 0100
Fax: 03 540 0122

Adelaide
Tel: 08 232 5550
Fax: 08 232 5551

Perth
Tel: 09 443 5122
Fax: 09 443 5262

ENTER 7901

microwave landing systems).

Braemac

Unit 1/59-61 Burrows Rd,
Alexandria NSW 2015
Phone: (02) 9550 6600
Fax: (02) 9550 6377
Branches: SA, WA, VIC
Core business: Design tools, component distribution/sales, subsystems, software, design and software implementation and programming
Gross electronics sales revenue: $30,100,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 46
Australian owned: Yes, private
Key executives: Danny Meneny, Joint Managing Director
Dino Caluisi, Joint Managing Director
Gari Scardina, Financial Controller
Scott Reeves, Sales Manager
Profile: The past decade has seen strong growth for the electronics manufacturing sector and this has enabled Braemac to participate in numerous designs and provide both technical and commercial assistance to customers. Braemac has recorded growth of over 25% in the year to June 1996 and anticipates continued growth through its entry into new market sectors, the offer of design and software services and new opportunities in New Zealand.

British Aerospace Australia - Electronic Systems GP

14 Park Way, Technology Park,
The Levels SA 5095
Phone: (08) 343 8211
Fax: (08) 343 6629
Branches: ACT, NT, NSW, VIC
Core business: Subsystems, communications, software
Gross electronics sales revenue: >$100,000,000 (company estimate)
R&D (as a percentage of revenue): 2.0%
Exports (as a percentage of sales):
Employees: 600
Australian owned: No, private
Key executives: Peter Smith, Managing Director
Nigel Hennessy, General Manager Electronics Systems
Roman Olesnicky, Group Technical Manager
Profile: Current contracts include: Parakeet project for Army electronic warfare equipment for Australian defence; electro-optic equipment, simulation, communications and surveillance, systems integration and software development, prime contracting.

CelsiusTech Australia

Endeavour House, Fourth Ave,
Technology Park SA 5095
Phone: (08) 343 3800
Fax: (08) 343 3778
Branches: ACT, NSW, QLD, VIC
Core business: Software, systems engineering and systems integration
Gross electronics sales revenue: $50,000,000
R&D (as a percentage of revenue): 1.0%
Exports (as a percentage of sales): 0.0%
Employees: 95
Australian owned: No, private
Key executives: Tomas Ahlberg, Managing Director
Goran Granberg, Technical Director
Lachlan Peter, Business Development Manager
Malcolm Peacock, Financial Director
Profile: CelsiusTech Australia is an internationally recognised high technology company specialising in defence software engineering and systems integration projects. It has successfully delivered the command and control systems and combat systems for the ANZAC ship project. It is also developing the Australian Army's command support system and the RAN's Mine Warfare Systems Centre.

Cisco Systems

Level 17, 99 Walker St,
North Sydney NSW 2060

AC&E Pty Limited

54 Blackwall Point Rd, Chiswick NSW 2046
Phone: (02) 9712 3555
Fax: (02) 9719 8548
Branches: ACT, NSW, VIC
Core business: Design, manufacture and distribution of interconnect products
Gross electronics sales revenue: $18,500,000
R&D (as a percentage of revenue): 2.5%
Exports (as a percentage of sales): 2.0%
Employees: 80
Australian owned: Yes, private
Contact: John Adams, Managing Director

Profile: The major activities of AC&E are centred on the design, development, manufacture and/or distribution of interconnect products such as baluns, cables, connectors, alarm panels, hubs and networking products and associated equipment for the telecommunications, data communications and broadcasting industries. The company is currently the sole supplier to Telstra of several interconnect products — designed and manufactured in Australia — that are used in the Telstra transmission network.

First incorporated in 1969, the company's business has seen strong expansion in recent years. The 1995/96 year was one of continued profitability which also saw ongoing product development for the telecommunications market as well as expansion of know-how and distribution arrangements for the data communications and computer networking markets.

1995/96 also saw AC&E reorganise its activities into two separate operating divisions, namely Telecommunications as well as Data Networking. This reorganisation incorporated a flattening of the management structure with product and policy decisions being made more immediate to market demands.

Also during 1995/96 AC&E exhibited with Austrade at CeBIT in Hanover and at CommunicAsia in Singapore as well as independently at industry exhibitions in Hanoi, Jakarta and Kuala Lumpur as part of its commitment to the development of export markets.

John Adams, who has been managing director through the company's period of expansion, says AC&E aims to continue to strengthen its core interconnect and networking activities through product and market developments across a range of RF/HF, broadcasting and computer networking applications. AC&E will also continue to base such developments on combining its own self funded R and D and manufacturing activities with the know how and expertise coming from selected alliances with high quality overseas organisations.

TELECOMMUNICATIONS
ACE
AND
NETWORKS

Phone: (02) 9935 4100
Fax: (02) 9957 4077
Branches: ACT, NT, QLD, SA, TAS, VIC, WA
Core business: Communications
Gross electronics sales revenue: $110,000,000 (company estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 130
Australian owned: No, owned by CSCO NASDAQ, US listed
Key executives: Scott Ferguson, General Manager
Brian Butler, Finance Manager
Anne Strachan, Marketing Manager
Profile: Cisco Systems is the leading global provider of internetworking solutions. Cisco's hardware and software products are used to link computers so that pepole have access to information regardless of differences in time, place or computer system.

Codan

81 Graves St, Newton SA 5076
Phone: (08) 305 0311
Fax: (08) 305 0411
Branches: NSW, WA
Core business: Electronics manufacturing, component distribution/sales and communications
Gross electronics sales revenue: $39,000,000
R&D (as a percentage of revenue): 6.3%
Exports (as a percentage of sales): 77.0%
Employees: 240
Australian owned: Yes, private
Key executives: M K Heard, Managing Director
N G Hall, Product Development Manager
Y A Gobolos, Satellite Manager
D J Jegredos, Marketing Manager
B E Pentland, Finance Manager
Profile: Design, manufacture and distribution of HF radio and C Band satellite transceivers through an international network of agents, dealers and customers. Sales are made to 140 countries. In 1995 Codan won the South Australian Manufacturer of the Year award and Large Exporter of the Year award.

Communitron (Aust)

Unit 1/5-11 Mellor St,
West Ryde NSW 2114
Phone:
Fax:
Branches:
Core business: Electronics manufacturing and communications
Gross electronics sales revenue: $7,600,000
R&D (as a percentage of revenue): 0.8%
Exports (as a percentage of sales):
Employees: 50
Australian owned: Yes, private
Key executives: George Weisske, General Manager
George Ting, Technical Manager
Profile: Communitron is principally a manufacturer and supplier of products for the telecommunications industry. Services include PCB assembly, mechanical assemblies, cable harnesses, in-circuit testing, functional and environmental testing, turnkey projects, project management and production engineering.

Cray Communications

12 Rodborough Rd,
Frenchs Forest NSW 2086
Phone: (02) 9928 0000
Fax: (02) 9928 0011
Branches:
Core business: Sale of data communication equipment
Gross electronics sales revenue: $36,352,000 (ASC data - parent company sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned: No, owned by Cray Electronics Holdings PLC, UK
Key executives: D.V. Arlidge, Managing Director
P.R. Turner, Finance Director
B. Slabas, Director
Profile: No information supplied.

Crusader Electronics

3/92 Bryant Street,
Padstow NSW 2211
Phone: (02) 9792 3922
Fax: (02) 9792 1446
Branches: VIC
Core business: Component distribution/sales
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 20
Australian owned: Yes, private
Key executives: Bishu Bojdak, General Manager
George van Mal, Sales & Marketing
Robert Sams, Finance
Rod Fritchley, NSW Sales Manager
Graham Johnson, Victorian Sales Manager
Margaret Butters, Quality Manager
Profile: Crusader is an importer/distributor of electronic components with the role of manufacturers' agent and distributor. Crusader supplies high quality components from manufacturers such as Kemet Electronics, Beyschlag,

Avnet EMG (Australia) Pty Ltd

(Incorporating Avnet VSI)

Unit C, 6-8 Lyon Park Road, North Ryde NSW 2113
Phone: (02) 9878 1299
Fax: (02) 9878 1266
Branches: QLD, SA, WA, VIC
Core Business: Distribution of electronic componentry
Gross electronics sales revenue: $51 million (est.) (excludes NZ revenue)
R&D (as a percentage of revenue): N/A
Exports (as a percentage of sales): 1.8%
Employees: 65
Australian owned: No, private
Key executives: Robert Crabbe, Managing Director; Leslie Torok, Finance Director
Profile: Avnet Inc USA purchased VSI Electronics (Australia) Pty Ltd in June 1995. VSI have succeeded in the Australian market place for over 30 years, now known as Avnet EMG (Australia) Pty Ltd, which incorporates the business units of Avnet VSI and Avnet Time, we are arguably the largest electronic component distributor in Australia excluding revenues from our NZ company) representing many of the world's premier manufacturers of active, passive, electro mechanical and interconnect components. The Company has expanded it's number of component franchises over the last year in an endeavour to further assist our O.E.M.s in their vendor reduction programs. ISO and UL certifications are in place with these processes used to drive for further operating efficiencies and productivity. Avnet Australia's Managing Director, Bob Crabbe says that the Company has integrated well into the Avnet global family in the first year with another strong year of growth achieved and plans laid to continue the trend across 96/97.

AVNET EMG AUSTRALIA

Arcotronics, ITT (Intermetal), Ohmite Manufacturing, CDE, Sakae, Elan, IVO etc. Our products include diodes, transistors, capacitors, resistors, relays.

Crystalaid Manufacture

194 Edward St,
Brisbane QLD 4006
Phone: (07) 3252 7713
Fax: (07) 3252 1590
Branches:
Core business: Electronics manufacturing
Gross electronics sales revenue: $24,000,000
R&D (as a percentage of revenue): 2.0%
Exports (as a percentage of sales): 22.0%
Employees: 75
Australian owned: Yes, private
Key executives: John Bryant, Managing Director
Rod Eades, General manager
Jaya Ganasan, Operations & Engineering
Les Willin, Accounts
Profile: Sole manufacturer of programmable hearing aids for export and supply to Australian hearing services for fitting to pensioners, and children. Recent installation of hybrid bonding facility. Company is accredited to ISO 9001.

Data Electronics (Aust)

7 Seismic Crt,
Rowville VIC 3178
Phone: (03) 9764 8600
Fax: (03) 9764 8997
Branches: NSW
Core business: Test and measurement equipment
Gross electronics sales revenue: $4,540,000
R&D (as a percentage of revenue): 12.0%
Exports (as a percentage of sales): 56.0%
Employees: 30
Australian owned: Yes, private
Key executives: Tony Schauble, Director Marketing
Terry Jones, Director Applications
Gary Jarvis, Director Finance
Graham Henstridge, Director Engineering
Profile: Data Electronics manufactures data loggers for science and industry. Exports 70% of production to over 30 countries. In 1995 it won a contract to supply $4.5 million of hydrological data loggers to China.

Datacraft

266 Maroondah Hwy,
Mooroolbark VIC 3138
Phone: (03) 9727 9111
Fax: (03) 9726 5300
Branches: ACT, NSW, QLD, SA, WA
Core business: Electronics manufacturing, communications, software, turnkey networking, IVR & messaging systems
Gross electronics sales revenue: $194,000,000
R&D (as a percentage of revenue): 5.3%
Exports (as a percentage of sales): 4.0%
Employees: 330
Australian owned: Yes, public
Key executives: George Kepper, Group CEO
Wayne Fitzsimmons, CEO Australian Operations
Phillip Belcher, CEO Datacraft Australia
Chris Johnston, CEO Datacraft Technologies
Scott Mann, CEO Datacraft Software
Profile: Close relationship with major US vendors covering wide area to local area networks, Internet to intranets. Joint development of end-end solutions for several US TDM MUX vendors using their own design NTUs.

E S Rubin Group

73 Whiting St, Artarmon NSW
Phone: (02) 9439 2333
Fax: (02) 9439 2278
Branches: QLD, SA, VIC, WA
Core business: Component distribution/sales
Gross electronics sales revenue: $4,100,000
R&D (as a percentage of revenue):

Artronic Productions (Australia)

48-64 Fitzroy St, Marrickville NSW 2204
Phone: (02) 577 1233
Fax: (02) 516 4820
Branches: Sydney, Melbourne
Core business: PCB manufacture
Gross electronics sales revenue: $9,000,000
R&D:
Exports:
Employees: 53
Australian owned: No, public listed
Key executives: Rowland Jones, General Manager/Director;
Ken Wales, National Sales Manager
Colleen Euston, Administration Manager

Profile: Since establishment in 1971 Artronic Productions has grown to be one of Australia's major PCB manufacturers. Artronics believes a focus on quality, delivery and service has lead to their success and growth.

1996 was a significant year for Artronic Productions. The company provided an investment of $2 million dollars to install the latest manufacturing equipment for multilayer PCBs including clean rooms and X-Ray registration verification.

With investment in latest world-wide production and testing technology, Artronics is currently expanding their Sydney plant to facilitate a specialised division for the production of multilayer printed circuit boards.

The implementation of a strategic management team and specialised staff ensure the company's quality objective. The company has obtained ISO 9002 Quality Certification and UL Recognition, and plans to have a capability of up to 10 layers by late 1996.

Exports (as a percentage of sales):
Employees: 16
Australian owned: Yes, private
Key executives: Eric Rubin, Managing Director
Brett Cameron, Manager Components
Phillip Marchant, Manager Finance & Administration
Profile: E S Rubin had its best year ever with major contracts with leading customers. 1995/96 saw several changes to its business infrastructure with centralised warehousing and sales/marketing.

Electronic Development Sales

Unit 2A, 11-13 Orion Rd,
Lane Cove NSW 2066
Phone: (02) 9418 6999
Fax: (02) 9418 6550
Branches:
Core business: Manufacturing equipment distribution/sales, component distribution/sales, test & measurement equipment, anti-static products
Gross electronics sales revenue: $5,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 12
Australian owned: Yes, private
Key executives: Erle Goodwin, Managing director
Henry Loh, Operations director
Maria Chiu, Company Secretary
John Usher, Marketing Manager
Julie Kerim, Systems Manager
Profile: Market leader in supplying Australia with the latest in overseas electronics developments for the last 20 years. EDS offers a diverse range of high-tech components, electronic manufacturing equipment and anti-static solutions. More recently enjoying success in the capital equipment markets with the range of Mydata pick and place machines.

ERG

247 Balcatta Rd,
Balcatta WA 6021
Phone: (09) 273 1100
Fax: (09) 273 1208
Branches: NSW, QLD, VIC
Core business: Electronics manufacturing, communications, software, fare-collection systems, stored value card systems
Gross electronics sales revenue: $130,000,000
R&D (as a percentage of revenue): 17.0%
Exports (as a percentage of sales): 54.0%
Employees: 550
Australian owned: Yes, public
Key executives: Sandy Murdoch, Chairman
Peter Fogarty, CEO
Ian Allen, Chief Financial Officer
Sarah Manners, Corporate Communications
Michael Lamb, Telecommunications MD
Chris Ring, Fare Collection MD
Profile: ERG is recognised internationally as a leader in the areas of automated fare-collection systems and specialised telecommunications products. Recent contracts include fare collection contracts in Belgium, France, Hong Kong, Canada and Malaysia and telecommunications contracts with ADC of the US and Nokia of Finland.

Ericsson Australia

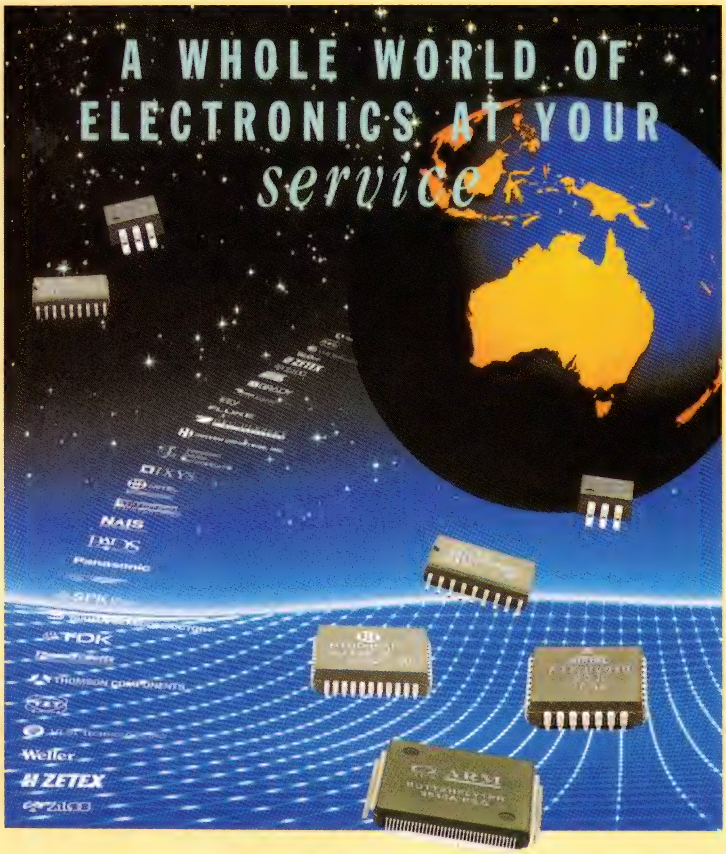
61 Riggall St,
Broadmeadows VIC 3047
Phone: (03) 9301 1000
Fax: (03) 9301 1361
Branches: ACT, NSW, QLD, SA, WA, TAS
Core business: Manufacturing equipment distribution/sales, electronics manufacturing, communications, telecommunications products and services
Gross electronics sales revenue: $800,000,000
R&D (as a percentage of revenue): 10.0%
Exports (as a percentage of sales): 13.0%
Employees: 2250
Australian owned: No, public
Key executives: Kjell Sorme, Managing Director
Bo Nilsson, Fixed Networks
Colin O'Reilly, Mobile Networks
David Dearman, Business Communications

GEC Electronics Division

38 South St, Rydalmere NSW 2116
Phone: (02) 9638 1888
Fax: (02) 9638 1798
Branches: QLD, SA, VIC, WA, Auckland, Wellington, Christchurch
Core business: Component distribution/sales
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 70
Australian owned: No, public
Key executives: Godfrey Hole, CEO
Dion Bourne, Finance Manager
Robert Roughton, General Manager
David Muller, Operations Manager

Profile: GEC Electronics is a broad line distributor of electronic components including microcontrollers, ASICs and complex telecommunications semiconductors. It provides an in depth technical support function including ASIC design and device programming.

GEC
ELECTRONICS



Dave Colbeck, Vodafone
Bill Zikou, Supply
Rob Brooker, Systems Design & Engineering
Peter Rule, Strategic Product Management

Profile: Ericsson is Australia's second largest telecommunications R&D facility and 1995 winner of an Australian Quality Award - manufacturing. Substantial contracts are in place for the supply of fixed and mobile switching equipment. Ericsson is achieving worldwide success in the export of Australian-made products and services.

Fabrication Australia

Unit 10, 76 Rushdale St,
Knoxfield VIC 3180
Phone:
Fax:
Branches: NSW
Core business: Manufacturing equipment distribution/sales, test & measurement equipment, bare-board test service
Gross electronics sales revenue: $2,000,000
R&D (as a percentage of revenue): 0.5%
Exports (as a percentage of sales): 4.0%
Employees: 15
Australian owned: Yes, private
Key executives: Mark Hearl, Managing Director
Wayne Hogben, Sales & Marketing
Matthew Greaves, Engineering
Lee Wapling, Quality

Profile: Fabrication Australia is Australia's leading test fixture specialist. The company has recently extended its test expertise to include bare board testing. Quality accreditation to ISO 9002 was achieved in 1994 and has enabled the company to win major defence contracts for the manufacture of test fixtures.

Farnell Electronic Components

72 Ferndell St,
Chester Hill NSW 2162
Phone: (02) 9644 7722
Fax: (02) 9644 5709
Branches:
Core business: Wholesaler of electronic components
Gross electronics sales revenue: $23,920,000 (ASC data - consolidated sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 100-199
Australian owned: No, private
Key executives:
Profile: No information supplied.

Fibernet

24 Laser Dr, Rowville VIC 3178
Phone: (03) 9764 2111
Fax: (03) 9764 2120
Branches: NSW, QLD, SA, WA
Core business: Communications, fibre optics
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue): 5.0%
Exports (as a percentage of sales): 15.0%
Employees: 65
Australian owned: Yes, private
Key executives: Allen Conduit, Operations Director
Bruce Board, Sales Director
Rick Hocking, Sales and Marketing
Mark Hesling, Export Sales
Brian Murrihy, Engineering
Reg Wright, Financial Controller

Profile: Fibernet is a major supplier of fibre optic solutions to Telstra, Optus and their telecommunications OEM manufacturers. In addition Fibernet services the commercial and industrial data communications markets and the needs of all industries for fibre optic solutions, be it audio, video, data or voice communications.

Fujitsu Australia

475 Victoria Ave,
Chatswood NSW 2067
Phone: (02) 9410 4555
Fax: (02) 9411 8603
Branches: ACT, QLD, SA, TAS, VIC, WA
Core business: Manufacturing

Hewlett-Packard Australia Limited

31-41 Joseph St, Blackburn VIC 3130
Phone: (03) 9272 2895
Fax: (03) 9898 7831
Branches: ACT, NSW, QLD, SA, WA
Core business: Test & measurement equipment
Gross electronics sales revenue: $634,000,000
R&D (as a percentage of revenue): 5.0%
Exports (as a percentage of sales):
Employees: 800
Australian owned: No, public listed (US)
Key executives: Bruce Thompson, Chairman & Managing Director

Profile: Hewlett-Packard has been part of the Australian community for over 25 years, and through its people and information products, has made a positive contribution to business, industry, engineering, medicine, science, education and government, including its ongoing involvement with the Federal Government "Partnerships for Development" program. Earlier this year HP officially opened its Australian Telecommunications Operation in Burwood, Victoria – a facility for R&D and the manufacture of advanced telecommunications products for the broadband communications market.

Our customers know of our leadership in technology in many different ways. Some may know us well for our calculators, others for our Open Systems computers, PCs and laser printers. Yet others may know the company better for test and measurement instruments, analytical products and medical equipment.

Our people take pride in delivery quality. What is most important to them is that our customers not only associate HP with market-leading, high-quality products but also the best in customer support for repair, site services, education and professional consultancy.

Hewlett-Packard Australia – a tradition of quality and commitment for a future of challenges and opportunities. HP is moving forward with Australia, and Australia with HP.

hp HEWLETT® PACKARD

equipment distribution/sales, electronics manufacturing, subsystems, communications, software, installation and support services, and IT consulting services
Gross electronics sales revenue: $755,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 1333
Australian owned: No, public unlisted - 80% Fujitsu (Japan), 20% ICL (UK)
Key executives: N J Roach, Managing Director
N Karasuda, Finance Director
D B Hughes, Chief Operating Officer
J Kranenburg, Executive GM (Telecommunications)
Profile: With revenues of US$36 billion, the parent company is the second largest manufacturer of computers worldwide and one of the world's leading telecommunications equipment suppliers. In Australia, the group markets computers, telecommunications products and services, software, consultancy, professional and computer maintenance services.

GEC Electronics Division

See enhanced listing on page T15.

GEC Plessey Telecommunications (Australia)

5-7 Slough Ave,
Silverwater NSW 2128
Phone: (02) 9350 9666
Fax: (02) 9350 9698
Branches: ACT, QLD, VIC
Core business: Communications, business systems
Gross electronics sales revenue: $33,023,000
R&D (as a percentage of revenue): 1.4%
Exports (as a percentage of sales): 20.0%
Employees: 141
Australian owned: No, owned by GEC (UK) 60%, Siemens (Germany) 40%
Key executives: Eric Green, Managing Director
Bob Robbins, Marketing Manager
Steve South, Finance Director
John McCudden, Sales & Service Director
Andrew Levido, Engineering Manager
Rod Green, Production Manager
Rod Levett, HR Manager
Tom Fitzgerald, Quality Manager
Profile: GPT is a global company supplying public and private switching equipment and services to over 100 countries. With a worldwide turnover in excess of $2 billion, GPT has established itself as a major player in telecommunications and applications equipment.

Global Lightning Technologies

Technopark,
Dowsings Point TAS 7010
Phone:
Fax:
Branches: ACT, NSW, SA, WA, VIC
Core business: Electronics manufacturing, lightning and transient protection, power conditioning and power conversion
Gross electronics sales revenue: $14,600,000
R&D (as a percentage of revenue): 8.5%
Exports (as a percentage of sales): 45.0%
Employees: 116
Australian owned: Yes, private
Key executives: Rick Gumley, Chairman/Director Advanced Technologies
Steve Gumley, Chief Executive Officer
Tony Surtees, Technical Marketing Manager
Wayne Temple, International Sales Manager
Barry Buckley, International Sales Director
Dennis Riva, Australian Manager
Profile: GLT exports to over 30 countries on five continents and produces innovative transient protection and power conversion products to markets in telecommunications, defence, mining and general industry. GLT employs 13 professional engineers and over a dozen skilled technical staff.

HarTec

See enhanced listing on page T17.

Hawker Batteries

119-127 Wicks Road,
North Ryde NSW 2113
Phone: (02) 9878 5000
Fax: (02) 9878 5555
Branches:
Core business:
Gross electronics sales revenue: $40,000,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

Hewlett-Packard Australia

See enhanced listing on page T16.

Honeywell

5 Thomas Holt Dr,
North Ryde NSW 2113
Phone: (02) 9353 7000
Fax: (02) 9353 8207
Branches: ACT, NT, QLD, SA, TAS, VIC, WA
Core business: Electronics manufacturing, communications, software, electronic assembly and wiring, training, metalwork manufacture
Gross electronics sales revenue: $60,000,000 (unaudited)
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 15.0%
Employees:
Australian owned: No, private
Key executives: John Wolfraad, Managing Director
Profile: Honeywell is the leading worldwide supplier of automation and control for homes and buildings, industrial, space and aviation. It looks for solutions that increase productivity, improve quality, reduce operating costs and create a safer, more comfortable environment in which to live and work.

HarTec

205a Middleborough Rd, Box Hill VIC 3128
Phone: (03) 9268 9000
Fax: (03) 9899 6980
Branches: ACT, NSW, QLD, SA, WA
Core business: Electronics manufacturing, component, networking distribution/sales
Gross electronics sales revenue: $137,939,000
R&D (as a percentage of revenue): 0.0%
Exports (as a percentage of sales): 18.0%
Employees: 200
Australian owned: Yes, public listed
Key executives: David Strong, Managing Director
Andrew Jacobson, Distribution
Jeff Ray, Manufacturing
Mark Preece, Finance & Administration
David Crainean, Business Development

Profile: HarTec provides electronics manufacturing services and distributes semiconductors, other electronic components, networking and computer products. The company has focused on developing and maintaining quality relationships with key customers and principals.

Huber + Suhner Australia

42 Wattle Rd,
Brookvale NSW 2100
Phone: (02) 9905 0000
Fax: (02) 9905 8023
Branches:
Core business:
Gross electronics sales revenue: $20,000,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

Hypertec

61 Talavera Rd,
North Ryde NSW 2113
Phone: 13 13 07
Fax: 13 13 09
Branches: ACT, QLD, VIC, WA
Core business: Manufacturing equipment distribution/sales, component distribution/sales, communications
Gross electronics sales revenue: $87,203,183
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 50.0%
Employees: 131
Australian owned: Yes, private
Key executives: Geoff O'Reilly, Managing Director
Colin Lillywhite, Sales & Marketing
David Evans, Product Development
Michael McGrath, Group Marketing Manager
Profile: Hypertec is developing a range of networking products and the HyperFormance PC range.

IBM (Wangaratta Manufacturing Services)

See enhanced listing on page T18.

ICM

5 Sirius Rd,
Lane Cove NSW 2066
Phone:
Fax:
Branches:
Core business: Electronics manufacturing
Gross electronics sales revenue: $3,800,000
R&D (as a percentage of revenue): 0.0%
Exports (as a percentage of sales): 80.0%
Employees: 52
Australian owned: Yes, private
Key executives: Carlos Piteira, Managing Director
Ian Hawkins, Sales Director
Profile: Company commenced trading on 1 January 1996 and secured major contracts with DSS, IGI, Ingenico and AD Instruments. New contract awarded for command modules for PABX applications.

Intel Australia

Level 2, 8-22 West St, North Sydney NSW 2060
Phone: (02) 9937 5800
Fax: (02) 9937 5899
Branches: VIC
Core business:
Gross electronics sales revenue: $100,000,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

IRH Components

1-5 Carter St,
Silverwater NSW 2128
Phone: (02) 9364 1766
Fax: (02) 9648 3505
Branches: SA, VIC
Core business: Component distribution/sales, subsystems
Gross electronics sales revenue: $13,200,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 34
Australian owned: No, owned by Bell-IRH Industries (public)
Key executives: N C Smith, Managing Director
R J van Es, Finance Director
Alan Smith, National Manager
Profile: IRH Components is a manufacturer of resistive components and a major distributor of electronic components. IRH Components represents the world leaders in their respective technologies, Murata , Fujitsu-Takamisawa, Fujitsu Semiconductors, CP Clare, Teccor, EAO, Fujisoku, Phoenix Contact and Hawker Batteries.

IBM (Wangaratta Manufacturing Services)

55 Coonara Ave, West Pennant Hills NSW 2125
Phone: 13 2426
Fax: (02) 9354 7766
Branches: VIC
Core business: Electronics manufacturing, contract manufacturing
Gross electronics sales revenue: $60,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 90%
Employees: 60
Australian owned: No, Wholly owned subsidiaryof IBM Australia, public unlisted
Key executives: Barry Sullivan, Site Manager
Stephen Gulbin, Contract Manufacturing Manager

Profile: The Wangaratta plant was established in 1976 for the production of typewriters. Personal computers replaced typewriters in 1984. To support this change in production, an electronic card assembly line was established in 1986.

Following on from other IBM sites, Wangaratta Manufacturing Services Pty Ltd, a wholly owned subsidiary of IBM Australia, entered the contract manufacturing market in 1992. IBM globally is now one of the top five largest contract manufacturers in the world.

To cater for the increase in production, a new SMT line was commissioned in 1994. Contract manufacturing increased further in 1995 and now accounts for well over half the production in the electronic circuit board assembly area.

IBM

Customers using Wangaratta's service have ranged from small companies through to large multinationals. Predominantly the industries serviced have been information technology and communications. Feedback from customers has been very positive.

James Hardie Building Services

17-19 Orion Rd,
Lane Cove NSW 2066
Phone: (02) 9928 7000
Fax: (02) 9928 7111
Branches: ACT, NT, QLD, SA, TAS, VIC, WA
Core business: Manufacturing equipment distribution/sales, communications, access control, fire service, mechanical &

electrical services, voicemail
Gross electronics sales revenue: $312,700,000
R&D (as a percentage of revenue): 0.6%
Exports (as a percentage of sales): 0.4%
Employees: 2000
Australian owned:
Key executives: John Moller, General manager
Carolyn Wakeham, Finance & Administration
Steven Mears, R&D Manager
Profile: James Hardie Building Services is a leading Australian manufacturer, supplier and contractor for systems and services installed in buildings. Located throughout Australia and NZ it employs 2000 people in 35 offices. Major contracts include voicemail systems for all Optus mobile users, Qantas Sydney domestic terminal upgrade and access control systems for numerous prisons around the country.

JNA Telecommunications

16 Smith St,
Chatswood NSW 2067
Phone: (02) 9935 5555
Fax: (02) 9417 5837
Branches:
Core business:
Gross electronics sales revenue: $66,979,000 (ASC data - consolidated sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned: public listed
Key executives:
Profile: JNA Telecommunications is a leading supplier of telecommunications and network computing systems and services to carriers, government and industry.

Jtec

Unit 3, 118-122 Bowden St,
Meadowbank NSW 2114
Phone:
Fax:
Branches: ACT, QLD, SA, VIC, WA
Core business: Electronics manufacturing, communications, test & measurement equipment
Gross electronics sales revenue: $38,000,000
R&D (as a percentage of revenue): 28.0%
Exports (as a percentage of sales): 5.0%
Employees: 260
Australian owned: Yes, owned by Techniche (public)
Key executives: John Riedl, CEO
Ezio Belfiglio, General Manager
Keith Murray, Corporate Marketing Manager
John Robinson, Chief Engineer
John Hooker, Financial Controller
Profile: Jtec focuses on delivering customer benefits to those requiring scalable wide area network access and switching solutions. Core competencies include ISDN (Australian, ETSI), ATM, switching, signalling, voice & data integration, voice compression and Legacy system integration.

Kenelec

2 Apollo Court,
Blackburn VIC 3130
Phone: (03) 9878 2700
Fax: (03) 9878 0824
Branches:
Core business:
Gross electronics sales revenue: (AEE estimated position)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

Keycorp

Level 9, 67 Albert St,
Chatswood NSW 2067
Phone: (02) 9415 2900
Fax: (02) 9415 1363
Branches:
Core business: Manufacturing equipment distribution/sales, electronics manufacturing, component distribution/sales, software
Gross electronics sales revenue: $80,000,000
R&D (as a percentage of revenue): 16.0%
Exports (as a percentage of sales): 45.0%
Employees: 350
Australian owned: Yes, public
Key executives: G Rintoul, General Manager
Ted Satchell, Business Development
Robert Douglas, Research & Development
Ian Neville, Cardcorp
Hugh Kelly, Australian Electronic Manufacturing Services
Profile: Keycorp is an Australian owned technology company established in the early 1980s to provide for the special individual requirements organisations have for technology. Recent contracts include Lloyds Bank and Halifax Building Society in the UK and close associations with Visa, MasterCard and Mondex stored value schemes.

Priority Electronics

189 Bay Rd, Sandringham VIC 3191
Phone: (03) 9521 0266
Fax: (03) 9521 0356
Branches: NSW
Core business: Design tools, subsystems, embedded single board computers
Gross electronics sales revenue: $5,000,000
R&D (as a percentage of revenue): 0.0%
Exports (as a percentage of sales):
Employees: 13
Australian owned: Yes, private
Key executives: Gail Coward, Managing Director/Financial Officer
Santo Gazzo, General Manager, Marketing Manager
Profile: Priority Electronics started in July 1989. In 1994 we achieved Certification as a Quality Endorsed Company to AS/NZS ISO 9002. 1995 saw us open a new office in Sydney and a move to larger premises in Melbourne.

We have established ourselves as a Total Solution provider for critical application computers and peripherals, power supplies, IC components, serial communications products, data acquisition and control cards, and signal conditioning products.

Priority is the Exclusive Distributor for Advantech, Power General, Unitrode, Micro Networks and Power Cube.

Priority is fortunate in having a strong team of dedicated and well qualified support staff. Continued additions to our facility and engineering staff will ensure our continued growth and service as a quality provider of PC based products and OEM manufacturing solutions.

Mayer Krieg & Co

50 Mary St, Unley SA 5061
Phone: (08) 291 3222
Fax: (08) 291 3200
Branches: NSW, QLD, VIC
Core business: Manufacturing equipment distribution/sales, component distribution/sales, subsystems
Gross electronics sales revenue: $15,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 5.0%
Employees: 45
Australian owned: Yes, private
Key executives: Peter Krieg, Joint Managing Director
Peter Mayer, Joint Managing Director
Profile: No information supplied.

MFB Products

114 Lewis Rd,
Wantirna South VIC
Phone: (03) 9801 1044
Fax: (03) 9801 1176
Branches: NT, NSW, QLD, SA, TAS, WA
Core business: Manufacturing equipment distribution/sales
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 50
Australian owned: Yes, private
Key executives: Brian Bilston, Managing Director
Trevor Barr, Sales/Marketing Manager
Jason Jenner, Technical Representative
Profile: Established in 1972 to supply the electronics industry with enclosures. Main contracts include the supply of cabinets to each Westpac bank branch in Australia, over 1000. It is also supplying over 500 cabinets to Optus throughout Australia.

Mitec

532 Seventeen Mile Rocks Rd,
Sinnamon Park QLD 4073
Phone:
Fax:
Branches: NSW, VIC
Core business: Electronics manufacturing, communications
Gross electronics sales revenue: $21,000,000
R&D (as a percentage of revenue): 8.0%
Exports (as a percentage of sales):
Employees: 140
Australian owned: Yes, public
Key executives: John Ness, Managing Director
John Griffith, Financial
Peter Bradley, Engineering
Kevin Berridge, Marketing
Profile: Mitec is currently involved in microwave links, satellite hardware, ground station equipment and high power amplifier design.

Morris Productions

12 Harp Street,
Campsie NSW 2194
Phone: (02) 9789 6200
Fax:
Branches:
Core business: Manufacturer of printed circuit boards and industrial graphics
Gross electronics sales revenue: $13,200,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 100-199
Australian owned: owned by Morris Australia
Key executives:
Profile: No information supplied.

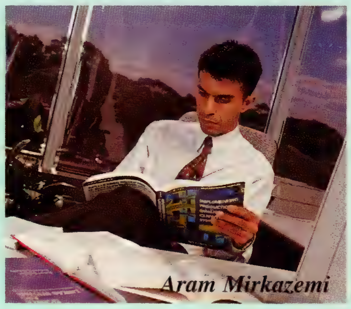
Motorola Australia

6 Caribbean Dr,
Scoresby VIC 3179
Phone: (03) 9213 7766
Fax: (03) 9213 7956
Branches:
Core business: Communications equipment and components
Gross electronics sales revenue: $383,128,000 (ASC data - sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 200-499

Protel International

Level 3, 12A Rodborough Rd, Frenchs Forest NSW 2086
Phone: (02) 9975 7710
Fax: (02) 9975 7720
Subsidiaries: Hobart, Tasmania and California, USA
Core business: Software
Gross electronics sales revenue: $8,000,000
R&D (as a percentage of revenue): 15%
Exports (as a percentage of sales): 93.0%
Employees: 23
Australian owned: Yes, private
Key executives: Nick Martin, Chief Executive Officer; Aram Mirkazemi, Research & Development; David Warren, Managing Director of Protel Technology Pty Ltd; Bruce Edwards, President of Protel Technology Inc., USA

Nick Martin


Aram Mirkazemi

Profile: Protel International Pty Ltd is a software development and marketing company that creates, sells and exports Microsoft Windows-based computer aided design (CAD) software for electronic engineers and designers. The company had revenues in 1995 of over $8 million and has now sold over 20,000 Windows-based CAD tools. With sales offices in California and Hobart and distributors in all significant industrial countries, Protel has established its position as a leader in Windows-based Electronic Design Automation (EDA) software.

Protel International is concerned with making high quality technical software solutions available to every engineer and scientist. This involves bringing the highest quality software to market at the lowest price that can support devlopment of the technology. To deliver this technology to every electronic designer in the world, Protel has built a marketing and distribution network that supports high-volume, low cost manufacture and delivery of software products.

Protel Systems was founded in Australia in 1985 by Nick Martin to market the first product, Protel-PCB. This low cost, easy-to-use, IBM-compatible DOS software was quickly accepted in the Australian electronic design community, and by mid-1986 the company was exporting its products through distributors in Europe and the United States. In 1987, the company introduced its first circuit design tool, Protel Schematic.

More recently Protel has released Advanced Schematic 3 (for Windows), the first product to be based on the new EDA Client/Server system and is now about to release Advanced PCB 3, the first PCB design tool to be based around this architecture. Protel recently acquired NeuroCad Inc. and released Advanced Route 3, one of the first EDA tools to use artificial intelligence. In addition, Protel has acquired compiler technology for Programmable Logic Devices (PLD) from Logical Devices Inc. of Florida USA. When released, this product will be called Advanced PLD and will be supplied as a server for EDA /Client.

Protel
International

Australian owned: No, owned by Motorola International Development
Key executives:
Profile: No information supplied.

National Instruments

PO Box 466, Ringwood VIC 3134
Phone: (03) 9879 9422
Fax: (03) 9879 9179
Branches:
Core business:
Gross electronics sales revenue: $4,500,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

Netcomm

25 Paul St North,
North Ryde NSW 2113
Phone: (02) 9887 2839
Fax: (02) 9888 5533
Branches: QLD, VIC, WA
Core business: Electronics manufacturing, communications, Internet service provider
Gross electronics sales revenue: $34,000,000
R&D (as a percentage of revenue): 8.0%
Exports (as a percentage of sales): 5.0%
Employees: 210
Australian owned: Yes, public
Key executives: Chris Howells, Managing Director
Luke Conte, Technical Director
Ross Rathwell, Chief Financial Officer
Chris McPherson, Marketing Manager
Profile: NetComm is Australia's leading PC connectivity supplier with Modems software and Internet services.

Nilsen Industrial

Phone:
Fax:
Branches:
Core business:
Gross electronics sales revenue: $10,500,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

Nilsen Instruments

150 Oxford St,
Collingwood VIC 3066
Phone: (03) 9419 9999
Fax: (03) 9416 1312
Branches:
Core business: Sales/distribution of electronic and scientific instruments
Gross electronics sales revenue: $11,227,438 (ASC data - sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 50-99
Australian owned: Yes, owned by Oliver J Nilsen (Australia)
Key executives:
Profile: No information supplied.

Nortel Australia

Level 5, 495 Victoria Ave,
Chatswood NSW 2067
Phone: (02) 9325 5200
Fax: (02) 9325 5222
Branches: ACT, QLD, WA, VIC
Core business: Communications
Gross electronics sales revenue: $75,283,000
R&D (as a percentage of revenue): 12.0%
Exports (as a percentage of sales): 8.5%
Employees: 650
Australian owned: No, subsidiary of Northern Telecom (Canada), a public listed company
Key executives: Brian Davis, Managing Director
Barry Southern, Sales
Alex Krawchuk, Marketing
Brian Hoppe, Finance
Profile: Nortel works with customers around the world to design, build and integrate complete digital broadband, enterprise, switching and wireless access networks for information, entertainment, education and business. Offers one of the broadest choices of network solutions in the global telecommunications industry. Nortel has shipped and installed more digital lines worldwide than any other company.

Omron Electronics

71 Epping Rd,
North Ryde NSW 2113
Phone: (02) 9878 6377
Fax: (02) 9878 6391
Branches: QLD, VIC
Core business: Component distribution/sales, software
Gross electronics sales revenue: $19,320,900
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 41
Australian owned: No, private
Key executives:
Profile: No information supplied.

Pacific Communications

10-12 Clyde St,
Rydalmere NSW 2116
Phone: (02) 9638 6400
Fax: (02) 9684 4264
Branches: QLD, SA, VIC, WA
Core business: Electronics manufacturing, communications
Gross electronics sales revenue: $9,337,622
R&D (as a percentage of revenue): 4.0%
Exports (as a percentage of sales): 4.3%
Employees: 60
Australian owned: Yes, private
Key executives: Dieter Monch, Managing Director
Lyndon Rumsey, Financial Controller
Co Smit, Group National Sales manager
Jacek Drwecki, R&D Manager
Steve Harlett, Engineering Manager
Dean Mills, National Marketing Manager
Profile: Pacific Communications specialises in research, design, development and distribution of state of the art closed circuit television surveillance systems and products for the security industry. All manufacturing is carried out in compliance with international quality standards.

Pacific Dunlop Cables Group

Phone:
Fax:
Branches:
Core business:
Gross electronics sales revenue: $675,000,000 (AEE estimate)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

PC Assemblies

5/13 Dympna St,
Dee Why NSW 2099
Phone:
Fax:
Branches:
Core business: Electronics manufacturing
Gross electronics sales revenue: $8,500,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 70
Australian owned: Yes, private
Key executives: Chris Jarvis, Managing Director
Carol Jarvis, Director
Terese Mathieson, Marketing Manager
Terry Pearce, Manufacturing Manager
Daryl Perry, Quality Manager
Profile: PC Assemblies is a sub-contract electronic manufacturer. Major industries serviced are gaming, telecommunications and medical. It prides itself on customer partnership and is certified to ISO9002. It has a highly qualified multi-skilled workforce to provide turnkey solutions for its customers.

Pepperl & Fuchs (Aust)

Unit 7, 72-74 Chifley Dr,
Preston VIC 3072
Phone: 1800 244 777
Fax: 1800 244 222
Branches: NT, NSW, QLD, SA, TAS, WA
Core business: Electronic products for process automation and factory automation
Gross electronics sales revenue: $5,500,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 21
Australian owned: No, private
Key executives: Richard Hurley, General manager
Steve Jones, National Sales Manager
Paul Bruno, Commercial Manager
Tharsren Nellen, Product Manager Factory Automation
Karl-Heinz Haller, Product Manager Process Automation
Profile: As a manufacturer of special electronic devices, Pepperl & Fuchs enjoys national and international recognition. Its sensors, sensor systems, EExi interface modules, control systems, level measuring equipment and bus systems switch, monitor and secure sensitive processes in industry.

Philips Electronics Australia

Philips House, 15 Blue St,
North Sydney NSW 2060
Phone: (02) 9925 3333
Fax: (02) 9925 3287
Branches: ACT, QLD, SA, TAS, VIC, WA
Core business: Component and manufacturing equipment distribution/sales, electronics manufacturing, subsystems, communications, test and measurement equipment, software and multi media publishing support centre.
Gross electronics sales revenue: $484,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 2300
Australian owned: No, owned by Philips Electronics (Netherlands)
Key executives: Justus Veeneklaas, Chairman & CEO
Grant Logan, Finance Director
Grant Hundleby, Company Secretary
John Boettcher, Corporate Affairs
Mark Bagsteer, Human Resources
Profile: During 1995 Philips' group sales in Australia grew by 31%, In December 1995 the company signed a $713 million Partnership for Development agreement with the Australian government. In June 1996 Philips announced a $64 million contract to supply radio telephone systems to PTTelkom Indonesia.

Powerbox

4 Beaumont Road,
Mt. Kuring-Gai NSW 2080
Phone: (02) 9457 2200
Fax: (02) 9476 2255
Branches:
Core business:
Gross electronics sales revenue: (AEE estimated)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

Precision Circuits

2-6 Glendale St,
Nunawading VIC 3121
Phone: (03) 9877 3222
Fax: (03) 9877 5079
Branches:
Core business: Printed circuit board manufacturer
Gross electronics sales revenue: $8,638,955 (ASC data - sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 50-99
Australian owned: private
Key executives:
Profile: No information supplied.

Priority Electronics

See enhanced listing on page T19.

Protel International

See enhanced listing on page T20.

QPSX Communications

33 Richardson St,
West Perth WA 6005
Phone: (09) 262 2000
Fax: (09) 324 1642
Branches: NSW
Core business: Electronics manufacturing, design tools, communications security hardware and software
Gross electronics sales revenue: $15,000,000
R&D (as a percentage of revenue): 20.0%
Exports (as a percentage of sales): 30.0%
Employees: 65
Australian owned: Yes, owned by Telstra
Key executives: Peter Abery, Managing Director
Louis van Graan, General manager/Engineering manager
Kevin Penter, Sales & Marketing
Paul Farrelly, Finance & Administration
Profile: QPSX provides communications products and services that deliver efficient and secure voice and data networking. QPSX supplies network management, broadband network interface modules for SMDS, frame relay and ATM equipment. QPSX also supplies communication security products and digital algorithms developed by Telstra Research Laboratories.

R&D Electronics

4 Plane Tree Ave,
Dingley VIC 3172
Phone: (03) 9558 0444
Fax: (03) 9558 0955
Branches: NSW
Core business: Design tools, Component distribution/sales, programming, FAEs to assist customers in design
Gross electronics sales revenue: $6,200,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 19
Australian owned: Yes, private
Key executives: Bill Woodward, CEO
Roger Sever, GM/Financial Director
Barry Hay, Technical/Quality
Graham Giulieri, National Product Manager
Peter Rorke, Sales (Vic)
Don Wilson, Sales (NSW)
Emma Szetey, Office manager
Kelly Heath, Marketing
Profile: In 1995, annual sales and book to bill ratio reached highest levels in the company's history, accreditation under AS3902 achieved, continuous improvement program initiated, and product range increased with signing of additional US and European agreements.

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- EMC Testing to European Immunity Standards
- Electrical Safety Testing to AS3260 for IT equipment
- ISDN Testing for Austel & New Zealand Telecom (basic & primary rate products)
- Austel testing for voice and data products (Austel TS001, TS002, TS004, TS006)
- NZ Telecom PTC testing for voice & data products
- Telecommunications testing for Hong Kong, Singapore & Malaysia
- Austel testing of cabling products to TS008
- Cable and link performance testing to IEC11801

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Austest Laboratories 4/87 Reserve Road, Artarmon 2064
Telephone (02) 437 4500 Fax (02) 437 4600

ENTER 7902

Racal Australia

3 Powells Rd,
Brookvale NSW 2100
Phone: (02) 9936 7000
Fax: (02) 9936 7036
Branches: VIC
Core business: Subsystems, communications, test & measurement equipment, software
Gross electronics sales revenue: $15,000,000
R&D (as a percentage of revenue): 10.0%
Exports (as a percentage of sales): 2.0%
Employees: 30
Australian owned: No, private, subsidiary of Racal Electronics (UK)
Key executives: David Paculabo, Managing Director
Phil Taylor, General Manager
Col Martin, Financial Controller
Mike Burcher, Project/Quality Manager
Ross Stevens, Service Manager
Profile: Racal Australia has been in operation for over 30 years and is a leading supplier of electronic technology products to the Australian market. Racal is primarily a sales, marketing, distribution and support operation addressing five main areas: data communications (ISDN), data security (encryption, access and virus protection), test & measurement instrumentation (GSM base station and mobile testing), voice and communication recording systems, and defence electronics

Richpac Technologies

58 Bath Rd, Kirrawee NSW 2232
Phone: (02) 9542 3688
Fax: (02) 9542 1137
Branches: QLD, SA, VIC, WA
Core business: Manufacturing equipment distribution/sales
Gross electronics sales revenue: $4,600,000
R&D (as a percentage of revenue): 7.0%
Exports (as a percentage of sales): 5.0%
Employees: 38
Australian owned: Yes, owned by Lemvest, a public listed company and subsidiary of the Lemarne Corporation
Key executives: Malcolm Inglis, Managing Director
Ross Campbell, General Manager
Peter Hebbeling, Sales Manager
Rao Bhogaraju, Engineering Manager
Profile: A manufacturer specialising in 19" racking systems for the data communications/ telecommunications markets. It is also a manufacturer of custom enclosures for the industrial and electronics markets, data communications (ISDN), data security (encryption, access and virus protection), test & measurement instrumentation (GSM base station and mobile testing), voice and communication recording systems, and defence electronics.

Rohde & Schwarz (Australia)

63 Parramatta Rd,
Silverwater NSW 2141
Phone: (02) 9748 0155
Fax: (02) 9748 1836
Branches: VIC
Core business: Test & measurement equipment, radio communications
Gross electronics sales revenue: $11,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 0.0%
Employees: 20
Australian owned: Yes, private
Key executives: A R Bean, Managing Director
B Hutchings, Financial Controller
J Urbina, Service Manager
S Haynes, Sales Co-ordinator
Profile: Main activities are importing, marketing and through life support of professional electronic measuring instruments, radio communication and EW equipment. Major contracts include 150 Model CMS communications test sets and direction finding systems for the Australian Army, and HF/VHF/UHF radios for the Australian Navy minehunters.

Rojone

61 Aero Rd, Ingleburn NSW 2565
Phone: (02) 9829 1555
Fax: (02) 9605 8812
Branches: QLD, SA, VIC, WA
Core business: Component distribution/sales, high performance cable assembly
Gross electronics sales revenue: $5,200,000
R&D (as a percentage of revenue): 10.0%
Exports (as a percentage of sales):
Employees: 30
Australian owned: Yes, private
Key executives: Livia Grabowski, Managing Director
Ian Janoska, Engineering Manager
Eleonore Cato, Financial Director
Profile: Rojone is currently involved in critically phased matched cable assemblies for Jorn project.

SAGEM Australasia

Unit 2, 44-48 O'Dea Ave,
Waterloo NSW 2017
Phone: (02) 9315 3500
Fax: (02) 9315 3555
Branches: VIC
Core business: Electronics manufacturing, communications, fax machines, GPS equipment
Gross electronics sales revenue: $12,632,000
R&D (as a percentage of revenue): 1.5%
Exports (as a percentage of sales): 0.5%
Employees: 35
Australian owned: No, private
Key executives: Dominique Legrand, Managing Director
Profile: SAGEM Australia sells GPS and inertial navigation systems, fax machines and other communications equipment. It manufactures commercial and military grade electronic boards and assemblies and is accredited to ISO 9002.

Scientific Devices Australia

See enhanced listing on page 26.

Scitec

2 Apollo Pl,
Lane Cove NSW 2066
Phone: (02) 9428 9555
Fax: (02) 9428 9988
Branches: ACT, QLD, SA, VIC, WA
Core business: Communications
Gross electronics sales revenue: $42,151,000
R&D (as a percentage of revenue): 10.0%
Exports (as a percentage of sales): 26.0%
Employees: 220
Australian owned: Yes, public
Key executives: Paul Magee, Group MD & CEO
Dwin Tucker, Finance
Colin Kempter, Marketing
Adrian Siebel, Operations
Quentin Goldfinch, R&D
Profile: Scitec is a designer and manufacturer of data communications equipment for corporate networks for worldwide distribution. Scitec specialises in the integration of voice and data over packet data networks and high speed access to carrier data networks. In Australia, Scitec is also a network integrator providing design, supply and support of a wide range of networking products.

ASH ELECTRONICS

PRODUCT GUIDE

WELWYN Components offer a full range of resistors, both commercial and precision grade. Welwyn supply custom hybrid circuits to some of Australia's largest manufacturers. Many pieces of European designed military equipment specify Welwyn resistors.

YAGEO offer excellent quality resistors and service. This ensures they are the first choice of many of Australia's largest companies. Yageo excel in commodity product and offer SMT resistors from 0402 to 2512 also an excellent range of SMT networks. Add to this a full range of well priced metal oxide, carbon and metal film resistor.

SEI Electronics formerly Stackpole Electronics offer a wide range of commodity product resistors as well as those now hard to find Carbon Composition Resistors.

ARK Electronics offer a full range of electrolytic capacitors including low ESR, Bi Polar, elevated temperature, snap in etc. Axial versions of most of the range is available and both stock and lead times are good.

IRC have had close association with the US military and automotive manufacturers for many years. As a result IRC are the preferred brand for a large number of US designs. Offering surface mount chips and networks to very close tolerance and low TCRs. Also low ohm power resistors, ideal for power supplies etc.

UCC offer a good range of SMT capacitors in all the popular sizes and dielectrics. In addition a full range of ceramic disc and monolithic capacitors are available.

KEKON have manufactured ceramic capacitors for many years in Europe, they are now available in Australia. In their standard range they offer case sizes 0504 to 2225 I pF to 82nF in NPO while the Z5U will extend to 6.8uF. Add to this tolerances as low as 0.2% and voltages as high as IO KV are available in a SMT capacitor and a whole new realm of possibilities is open to the product designer.

DC Components offer a comprehensive range of diodes, small signal, fast recovery, zener diodes, shotkys etc. Also MELF packaged diodes and bridge rectifiers rated up to 35Amps.

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Queensland readers Ph: (07) 5593 5539

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PO Box 5
Bateau Bay NSW 2261

ENTER 7903

Siemens

544 Church St,
Richmond VIC 3121
Phone: (03) 9420 7111
Fax: (03) 9420 7309
Branches: NSW, QLD, SA, WA
Core business: Component and manufacturing equipment distribution/sales, electronics manufacturing, design tools, subsystems, communications, test & measurement equipment, software
Gross electronics sales revenue: $419,000,000 (includes NZ)
R&D (as a percentage of revenue): 15.0%
Exports (as a percentage of sales): 7.0%
Employees: 1494
Australian owned: No, private, subsidiary of Siemens (Germany)
Key executives: Klaus Lahr, Managing Director
Barry Roberts, Commercial
Ockert Van Zyl, Telecommunications
John Coulton, Electrical Engineering
Geoff Fagan, Corporate Communications
Profile: Siemens is active in telecommunications networks, communications equipment, power engineering, automation, standard electrical products, electronic components, electrical contracting, plant maintenance, manufacturing and training, installation.

Signalling Technology

107 Seaford Rd,
Seaford VIC 3198
Phone: (03) 9786 0077
Fax: (03) 9786 0063
Branches:
Core business: Electronics manufacturing, communications, software, contract SMD assembly
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 70.0%
Employees: 48
Australian owned: Yes,
Key executives: John Barber, Managing Director
David Bailey, Manufacturing & Sales
Profile: No information supplied.

Scientific Devices Australia

2 Jacks Road,
South Oakleigh VIC 3167
Phone: (03) 9579 3622
Fax: (03) 9579 0971
Branches: NSW, SA
Core business: Communications, test & measurement equipment
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 17
Australian owned: Yes, private
Key executives: Graeme Sharp, Managing Director
Hamish Clark, Sales Director
Ron Guest, Calibration
Lindsay Gibson, Service Manager
Mark Lotter, NSW Office Manager
Roger Gale, SA Office Manager
Profile: Scientific Devices has been marketing electronic test & measurement equipment for over 25 years and in this period has represented major overseas manufacturers including: Wavetek, Datum, Boonton, ENI Elgar, Gigatronics, Iotech, Lecroy, Keithley, Keytek and Melcher. Scientific Devices also offers complete support services via its NATA laboratory and service engineering department. It also has ISO9002 certification.

Skandia Electronics

183 Burwood Rd,
Hawthorn VIC 3122
Phone: (03) 9819 2466
Fax: (03) 9819 4281
Branches: NSW
Core business:
Gross electronics sales revenue: $8,354,000
R&D (as a percentage of revenue): 1.0%
Exports (as a percentage of sales): 5.0%
Employees: 22
Australian owned: Yes, private
Key executives: Warwick Lee, Managing Director
David Harris, General manager
Leon Senior, Distribution & Marketing
Fred Atkins, NSW state manager
John Kabris, Technical Services
Profile: Skandia started out as an importer/distributor of electronic components. It now services the communications, satellite and Pay TV industries. During 1995/96 Skandia was awarded a major contract for the supply of field strength meters to Telstra.

TechComm Group

30 Balfour St,
Chippendale NSW 2008
Phone: (02) 9699 8300
Fax: (02) 9698 1339
Branches: ACT, QLD, SA, TAS, VIC, WA
Core business: Design tools, communications, software, telecommunications management services
Gross electronics sales revenue: $16,610,000
R&D (as a percentage of revenue): 6.0%
Exports (as a percentage of sales): 19.0%
Employees: 150
Australian owned: Yes, public listed
Key executives: David Oertle, CEO
John Scheller, Services
Frank Kraft, Operations
Lou Kosztelny, Financial Officer
Profile: Australian company specialising in the development and management of leading edge technologies. The four main areas are: power generation simulators; telecommunications management and technical expertise; maintenance services to banking, finance and retail industries; and distribution of Symbol technologies equipment.

Tech-Rentals

12 Maroondah Hwy,
Ringwood VIC 3134
Phone: (03) 9879 2266
Fax: (03) 9879 4310
Branches: ACT, NT, NSW, QLD, SA, WA
Core business: Design tools hire and sale, communications hire, t&m equipment hire and sale, computers and peripherals hire and sale
Gross electronics sales revenue: $16,383,571
R&D (as a percentage of revenue):
Exports (as a percentage of sales): 25.0%
Employees: 80
Australian owned: Yes, private
Key executives: Paul Jindra, Managing Director
Paul Brooker, General Manager
Lee Collars, Group Service Manager
Gregory Moult, Company Secretary
Ashley Jamieson, Computer Division Manager
Charles Beavis, Communications Division Manager
Profile: Tech-Rentals is primarily an equipment hire and finance organisation with equipment sale being an important secondary activity. Equipment comprises test instrumentation, personal computers and peripherals, and personal communications equipment. Customers include all levels of government and private enterprise organisations. Overseas offices are located in New Zealand, eastern Europe and SE Asia.

Tektronix Australia

80 Waterloo Rd,
North Ryde NSW 2113
Phone: (02) 9888 7066
Fax: (02) 9888 0125
Branches: ACT, QLD, SA, VIC

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ENTER 7904

Core business: Test & measurement equipment
Gross electronics sales revenue: $20,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 76
Australian owned: No, private
Key executives: Brian Currie, Managing Director
John Irwin, Financial Controller
Peter Roan, Sales, Test & Measurement
Profile: Tektronix is a pioneer in the measurement and display of electronic signals. It is a major force today in many product areas including: oscilloscopes, display terminals, video/audio production and broadcasting systems, video & audio test sets, signal generation & conditioning equipment, colour printers, high speed test equipment.

Tenrod Electronics

5/20-30 Stubbs St,
Silverwater NSW 2128
Phone: (02) 9748 0655
Fax: (02) 9748 0258
Branches: VIC
Core business: Electronics manufacturing, component distribution/sales
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 16
Australian owned: Yes, private
Key executives: Rodney Lai, Managing Director
Brendan Lai, Director Finance & Customer Service
Ian Lai, Sales
Frank Yong, Victoria Operations
Profile: Tenrod is involved in the importation and distribution of computer ICs and peripherals, PC boards, and active and passive components.

VME Systems Pty Ltd

26 Harker Street, Burwood VIC 3125
Phone: 03 98888211 **Fax:** 03 98888271
E-Mail: info@vme.com.au
Branches: Sydney Suite 306, 220 Pacific Hwy, Crows Nest 2065
Core Business: Computer hardware and software for embedded/industrial applications.
Gross electronics sales revenue: Not for publication
Key executives: Michael Hornsby, Managing Director; Peter Mountford, National Sales Manager; Tony Kishazi, Southern Region Sales Manager

Profile: For more than 10 years VME Systems has been supplying core real-time technology to Australia's leading companies in defence, communications and research. They provide a complete range of products including embedded single board computers, real-time operating systems, Unix systems, analogue and digital i/o, specialist interfaces, enclosures and backplanes. VME Systems assist their clients in developing real-time systems by providing system integration, ongoing technical support for both hardware and software, device driver development, and training.

University Paton

Phone: (02) 9585 5070
Fax: (02) 9590 4021
Branches:
Core business:
Gross electronics sales revenue: $32,293,000 (ASC data - sales revenue)
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: University Paton's Australian operations consist of three divisions, Advanced Component Distributors, Elektron and Integrated Circuit Distributors. Its aim is to be a dominant marketer domestically and move progressively into the Asia Pacific region.

Utilux

14 Commercial Rd, Kingsgrove
NSW 2208
Phone: (02) 9150 0155
Fax: (02) 9502 1753
Branches: ACT, QLD, SA, WA, TAS, VIC
Core business: Electronics manufacturing, Component distribution/sales, project management, stamping/moulding/assembly
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 167
Australian owned: Yes, private
Key executives: P Janssen, Managing Director
C Janssen, Deputy MD
B Seth, I&E Group
R Hodges, Engineering
S Fraser, Financial Director
R J Pearce, Interconnection systems
Profile: Utilux is a market leader in Australasian electrical and electronic interconnection technology. In automotive, appliance, power and telecommunication industries, Utilux is a name that is recognised globally as one that is innovative and responsive to customer needs.

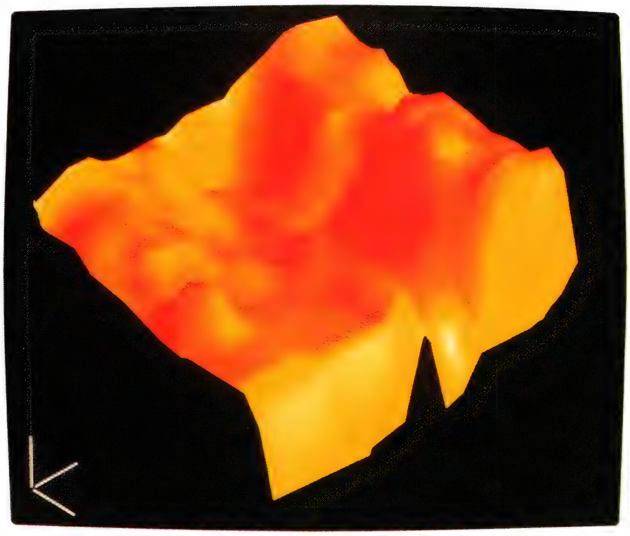
Veltek Australia

9-10 Bastow Pl,
Mulgrave VIC 3170
Phone:
Fax:
Branches:
Core business: Electronics distribution
Gross electronics sales revenue: No information available
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 50-99
Australian owned: private
Key executives:
Profile: No information supplied.

Vision Systems

Phone:
Fax:
Branches:
Core business:
Gross electronics sales revenue: $9,700,000 (ASC data - operating revenue)
R&D (as a percentage of revenue):

Behind many a great control system stands the language of engineering.



Empirical data is routinely used in SIMULINK *block diagrams. Here, a lookup table has been plotted showing a correction surface for manifold pressure as a function of engine speed.*

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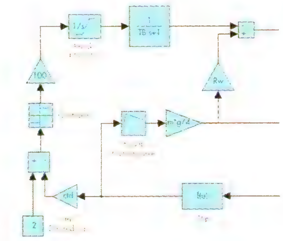

Portion of an ABS block diagram, chosen from one of five example cases in the new SIMULINK Automotive Examples *booklet (call us for your copy).*

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At Chrysler, engineers use MATLAB for development of advanced powertrains. Photo of Dodge Viper R/T10 Roadster, courtesy Chrysler Corporation.

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ENTER 7905

Exports (as a percentage of sales):
Employees:
Australian owned:
Key executives:
Profile: No information supplied.

VME Systems

See enhanced listing on page T28.

Wandel & Goltermann

42 Clarendon St,
South Melbourne VIC 3205
Phone: (03) 9690 6700
Fax: (03) 9690 6750
Branches: NSW
Core business: Test & measurement equipment
Gross electronics sales revenue: Not for publication
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 27
Australian owned: No, owned by Wandel & Goltermann (Germany)
Key executives: Stan Condy, Regional Director Asia Pacific
Profile: Wandel & Goltermann is a market leader in the design and manufacture of test equipment for data and telecommunications manufacturers and users. Wandel & Goltermann has manufacturing divisions in USA, Germany, UK and France. Australia is the regional headquarters for Asia.

Wormald Technology

176 South Creek Rd,
Dee Why NSW 2099
Phone: (02) 9981 0611
Fax: (02) 9971 1759
Branches:
Core business: Manufacturing equipment distribution/sales, electronics manufacturing, subsystems, engineering design, project management, systems integration
Gross electronics sales revenue: $20,000,000
R&D (as a percentage of revenue):
Exports (as a percentage of sales):
Employees: 120
Australian owned: Yes, owned by Tyco Australia
Key executives: Leo Browne, Managing Director
Richard Wilson, General Manager
Peter Hill, Sales & Marketing Manager
Robin Chalmers, Manufacturing Manager
Bruce Hunter, Engineering Manager
Elias Barakat, Operations Manager
John Crowley, QA Manager
Profile: Major exports are software and hardware design, systems integration, project management and contract manufacture.

Editorial

continued from page 3

facility in Sydney.

Top Australian-owned company for exports was Perth-based ERG, which came in third with $70.2 million earned in exports, representing 54% of the company's gross sales revenue. Like Alcatel, ERG has recently won some substantial overseas infrastructure projects.

Protel International, while it didn't make the top ten, was notable for the fact that a massive 94% of the company's gross sales revenue came from exports. This figure demonstrates the worldwide acceptance of its EDA software range. Protel's PCB design software is used extensively throughout the world and has enhanced Australia's reputation for producing quality software.

Highest R&D expenditure

Australia has never been perceived traditionally as a centre for electronics R&D. That's not to say Australia isn't considered an inventive nation. After all, the petrol lawn mower and the rotary clothes hoist are Australian inventions. But a general perception is that high-tech electronics R&D is not viable in Australia because of the high initial investment. The table on page T5 (*Top 10 companies — R&D expenditure*), however, shows the top 10 spenders investing something like $318 million per year in research and development in this country, which is certainly not chicken feed.

Once again communications was the driving force, with companies such as Ericsson, Alcatel and Siemens spending well over $50 million each in R&D.

Keycorp, a major player in the smart-card industry, invested $12.8 million in R&D last financial year, an indication of the seriousness with which it views this up-and-coming technology.

People power

Ask any managing director what makes a company great and they'll tell you it's the people that work for it. Keeping this in mind, the table on page T6 (*Top 10 companies — Revenue per employee*) gives the top 10 companies ranked by revenue per employee.

All of the companies in the top 10 managed to get over half a million dollars per year revenue for each person they employ. Not a bad return on investment (unless the employees are incredibly well paid!).

It's interesting to note that most of the companies in the top 10 listed their core business, or part of it, as distribution and sales — manufacturers tended to appear well down the list.

Most improved

As well as asking for revenue from the last financial year, the survey asked companies to supply details about the previous year's performance. The table on page T6 (*Top 10 companies — Increased sales revenue*) lists the top 10 improvers.

Overall, manufacturers seemed to have had a pretty good last financial year. AEMS, PC Assemblies and Crystalaid all had a considerable increase in revenue. *AEE* has made mention in several articles over the last few years of the maturing of the Australian electronics manufacturing industry, and this is perhaps an indication of the process. Of course the figures mostly represent sales in 1995 and it will be interesting to see if this sector continues to see high growth throughout 1996. Several manufacturers have reported a slow first half this year.

Both Cisco Systems and Priority Electronics had good years, managing to double their previous year's sales figures.

Overall, the average revenue increase for all companies in the top 100 was a healthy 25%, though there was a minority of companies reporting a decrease in revenue.

Until next year...

In recent months, *AEE* has had to report on the financial troubles of a number of prominent Australian electronics companies. There's no doubt the economy in general has been slow of late and is still to settle down after the trauma of a change of government. The electronics industry, as our survey shows, has a major role to play in this country's economy.

In the US recently, high-tech companies have been hard hit on the Wall Street exchange, with reports that some electronics businesses have had to close up shop because of cash-flow problems. There's talk there of overconfident investment in technology companies, and panic when results aren't immediate.

So far Australia hasn't suffered the same fate, but as they say, twelve months is a long time in business (and politics). *AEE* looks forward to bringing you the 1997 top 100, and seeing how this year's big guns fare over the next year.

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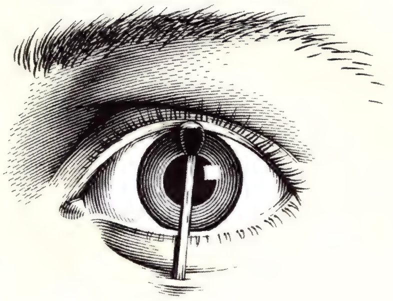

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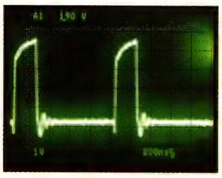

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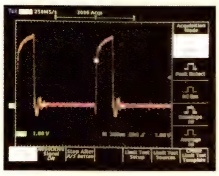

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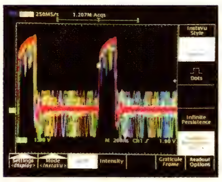

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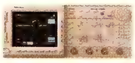

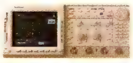

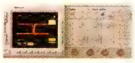

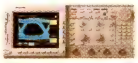

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Bandwidth	500 MHz	500 MHz	500 MHz	500 MHz	1 GHz
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Max. Sample Rate	1GS/s	2 GS/s	1 GS/s	2 GS/s	4 GS/s
Max. Record Length	250K	500K	250K	500K	500K
Max. Wfm. Acquisition Rate	100,000 W/s	100,000 W/s	180,000 W/s	400,000 W/s	400,000 W/s

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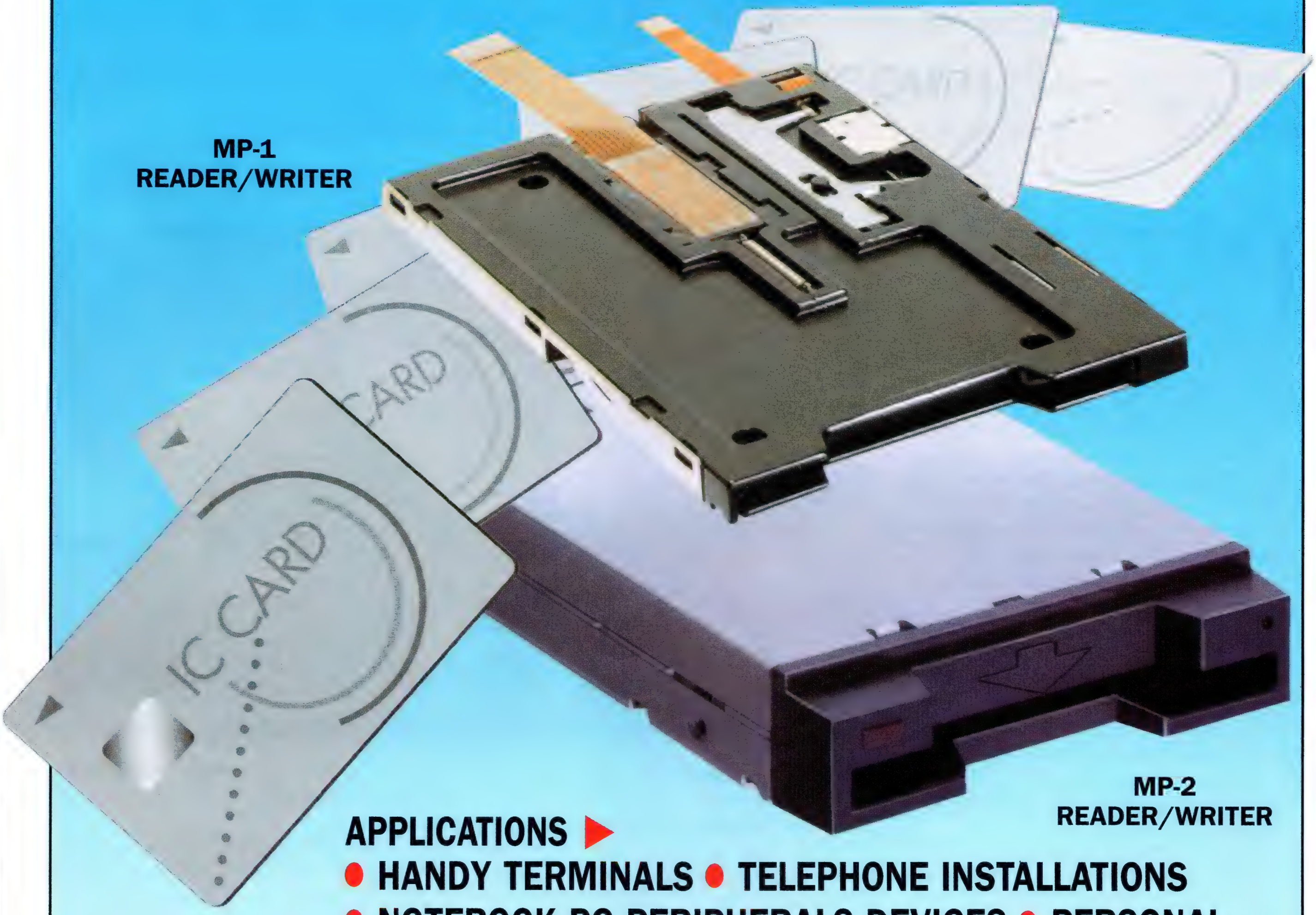

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Silicon carbide

The power semiconductor material of the future

Within the next decade silicon carbide (SiC) can be expected to join and possibly even supplant silicon as the material of choice for power semiconductor devices, especially for voltages from 500V upwards. *Dr Karl Bergman* looks at the future of power semiconductors.

Power electronics design engineers have searched for years for a device that is capable of blocking high voltages in the off-state, conducting large currents in the on-state and being switched from one state to the other with a minimum of energy all without any unnecessary losses.

Although an ideal switch with this capability is not yet available, several types of switch are in use that come close to it. Often, the semiconductor switch's high power losses will force designers to choose a less-than-ideal type of switch. This problem is further aggravated at higher system voltages.

The metal oxide semiconductor field effect transistor(MOSFET) is perhaps the device that best approximates the ideal switch described. Unfortunately, it has hitherto only been used for applications with relatively low voltages, since the losses for a given current density increase very rapidly with the blocking voltage.

The insulated gate bipolar transistor (IGBT) is, in a sense, a MOSFET whose structure has been modified to circumvent that device's inherent disadvantages, though at the cost of higher switching losses. During the 1980s the IGBT deposed the bipolar junction transistor as the power semiconductor of choice for blocking voltages from a few hundred volts up to 2kV. Above 2kV, the gate turn-off (GTO) thyristor is still holding its own against the IGBT. While the GTO is able to handle very high powers per device, it requires a considerably more complex control circuit than that needed to drive a MOSFET or IGBT.

What the power electronics circuit designer wants is therefore a device with the ease of use of the MOSFET and the power handling capability of the IGBT and GTO. This is precisely what MOSFETs based on SiC offer.

Silicon carbide devices

SiC has a breakdown strength which is about ten times higher than the value for silicon, resulting in much lower losses for SiC-based devices. For example, MOSFET structures based on SiC should be able to handle breakdown voltages of several kilovolts, whereas the maximum value for corresponding silcon (Si) devices is limited to between 500 to 1000V.

Historically, new types of switch have more or less revolutionised the way power electronics systems are built. For example, the introduction of the GTOóthe first really high power device to have turn-off capabilityóchanged the way locomotive drives are designed, allowing DC and synchronous machines driven by phase-commutated converters to be replaced by AC motors driven by force-commutated voltage source converters. In the industrial drive sector, the introduction of the IGBT has led to a substantial simplification of the power and control circuits, allowing improved performance as well as a reduction in costs.

SiC can handle much higher field strengths

To sustain a voltage U_b the blocking pn-junction of a semiconductor has to have a certain thickness. This must ensure that the maximum electric field E_{max} that the material will withstand before breakdown is not exceeded. The minimum thickness W of the junction is given by:

$$W > \frac{2U_b}{E_{max}} \qquad (1)$$

(The factor 2 can be omitted under certain design conditions.)

The prime advantage of SiC is that its E_{max} value is about ten times the figure for Si. For a given voltage, the required thickness of a SiC device will therefore be only one tenth the thickness required for a corresponding Si-based device.

In the following equation, more generally known as Maxwell's equation, account is also taken of the doping (ie,

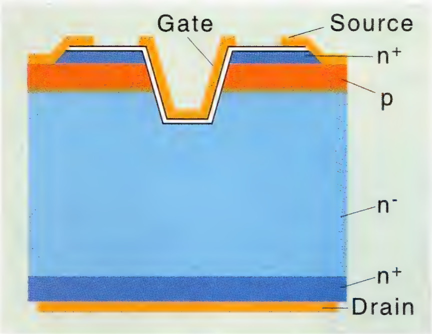

Figure 1. Structure of a possible silicon-based MOSFET. The n- region is the voltage-sustaining part of the device and has most influence on its conduction properties.

the controlled impurity content) of the material:

$$\frac{dE}{dx} = \frac{\rho}{\varepsilon\varepsilon_0} = \frac{qN_d^+}{\varepsilon\varepsilon_0} \qquad (2)$$

In this equation, ρ is the space charge density, ε the permittivity, ε_0 the electrical field constant, q the elementary charge, and N_d^+ the ionised donor concentration. It has been assumed that the voltage is sustained by a low-doped n-type layer, which is the case in most power devices (ie, Si as well as SiC).

Assuming a constant doping density and combining equations (1) and (2), the following relationship is obtained:

$$N_d^+ < = \frac{\varepsilon\varepsilon_0 E_{max}^2}{2qU_b} \qquad (3)$$

Thus, for any given breakdown voltage and with the ten times stronger field that is possible with SiC, the doping in the low-doped n layer can be around one hundred times higher than with Si.

SiC MOSFETs exhibit lower conduction losses

MOSFETs are the power switches with the most attractive properties for the circuit designer and end-user (see *Figure 1*). As mentioned, however, the MOSFET has hitherto been used only for breakdown voltages of up to a few hundred volts. One explanation of this is given by the following equation:

$$r_{ds,on} = \frac{4U_b^2}{\mu\varepsilon\varepsilon_0 E_{max}^3} \qquad (4)$$

In this equation, $r_{ds,on}$ is the specific resistance (measured in Ωcm^2) of the blocking junction, also referred to in the case of a vertical MOSFET as the drift region. The resistance increases with the width of the drift region and decreases with increased doping, since this leads to a larger number of the charge carriers that carry the current. μ gives the mobility of these charge carriers, which are usually electrons.

According to equation (4), the resistance of the drift region of the MOSFET increases in proportion to the square of the breakdown voltage. In the case of Si, intolerably high resistance values are reached with just a few hundred volts. In addition, it is observed that the resistance drops in proportion to the cube of the critical field. Since the critical field strength of SiC is some ten times that of Si, the conduction losses of a SiC MOSFET will be dramatically lower than for a Si device, at least in the breakdown voltage range where the conduction losses are dominated by the drift region. This applies to all so-called unipolar devices (i.e., devices that rely on only one carrier type to pass current), including MOSFETs, junction field effect transistors (JFETs) and Schottky diodes.

Bipolar devices for higher breakdown voltages

Since the Si-based MOSFET cannot be used for applications with breakdown voltages above a few hundred volts, the circuit designer has to resort to bipolar devices for the higher voltage ranges. As can be seen from equation (3), the resistance is limited by the number of available charge carriers (N_d^+). In bipolar devices (eg, pn-diodes, IGBTs and GTOs) the number of carriers is increased by injection from the anode and cathode emitters when the device is switched on. This leads to a dramatic reduction in the conduction losses compared with MOSFET structures. Since electrons are injected by the cathode and holes by the anode, the current is carried by both negative electrons and positive holes - hence the term 'bipolar' devices.

The drawback of bipolar carrier injection is that the excess charge has to be removed from the device during turn-off before a return to the blocking state is possible. The removal takes place via a current in the reverse direction plus so-called recombination, ie. mutual neutralisation of the holes and electrons. The time required to remove the excess carriers is far from negligible, and during this interval both the voltage and current may have high values at the same time, leading to a sharp increase in the switching losses. The advantage of relatively low conduction losses is therefore traded off against relatively high switching losses.

Carrier removal is, of course, also necessary in MOSFETs and other unipolar devices, but the losses associated with them are normally much smaller than for the bipolar devices. The total value of the injected specific charge q is given by:

$$q_{inj} = J\tau \qquad (5)$$

In this equation, J is the current density and τ the so-called minority carrier lifetime, ie. the average time it takes for an electron and a hole to recombine. The lifetime in power devices is determined by the concentration of certain defects, such as impurities. The manufacturer seeks an appropriate trade-off between the conduction and switching losses for each type of device according to its intended application.

Bipolar SiC thyristors for voltages above 10kV

As already mentioned, the circuit designer only resorts to bipolar devices when the system's voltage is too high for unipolar devices, such as MOSFETs and Schottky diodes. It has already been said that SiC will allow MOSFETs and Schottky diodes to be used which feature much higher breakdown voltages than are possible with Si. Thus, it can be expected in the future that MOSFETs will be used for most applications, including those requiring power devices for several kilovolts.

Some applications, such as static var compensation and HVDC transmission, feature system voltages that are much higher than the breakdown voltage which is possible with a power device based on either type of material. In such cases, the only solution is to connect the devices in series.

The breakdown voltage of the devices is chosen so as to obtain the best possible system performance and minimum losses. The thyristors used for these applications today typically feature a breakdown voltage of 6 to 7kV, a value which constitutes a trade-off between cost, performance, conduction losses and switching losses. Such high breakdown voltages call for Si thicknesses approaching 1mm and lifetimes in the region of 100µs, resulting in considerable switching losses.

With SiC, the optimum breakdown voltage for these application areas is likely to be much higher, and devices with a breakdown voltage easily exceeding 10kV are conceivable. The required minority carrier lifetimes would lie between 1 and 10µs, offering the possibility of an acceptable switching performance.

High temperature performance

It is generally considered wise to operate bipolar power devices based on Si below 125°C, whereas operation of unipolar devices, such as MOSFETs, is possible up to temperatures of 150°C. These restrictions can be explained physically by the higher reverse leakage currents, which cause higher temperatures in the pn-junctions, leading to an increased risk of thermal runaway. Since the carrier lifetime increases, there is an increased risk of parasitic, destructive processes being triggered. Finally, the reduction in mobility leads to an increase in conduction losses in unipolar devices. A fundamental limitation is that the operating temperature must lie below the temperature at which the semiconductor material becomes intrinsic, ie. the point where the carrier density is no longer determined by the doping, but by the band gap of the semiconductor. Above this limit, all current control and voltage blocking capability is lost. For Si, this limit occurs around 300∞C.

SiC, on the other hand, can be operated at much higher temperatures. The leakage currents in the pn-junctions are extremely small, permitting voltage blocking at temperatures considerably higher than 300∞C. The intrinsic limit is not reached until well over 1000°C.

A SiC-based MOSFET has been operated by a US research team, for example, at a temperature of 650°C. This high temperature capability is certain to have several benefits for the designers of power electronics systems. It should be emphasised, however, that the low losses described apply to operating temperatures and current densities similar to those usual for Si.

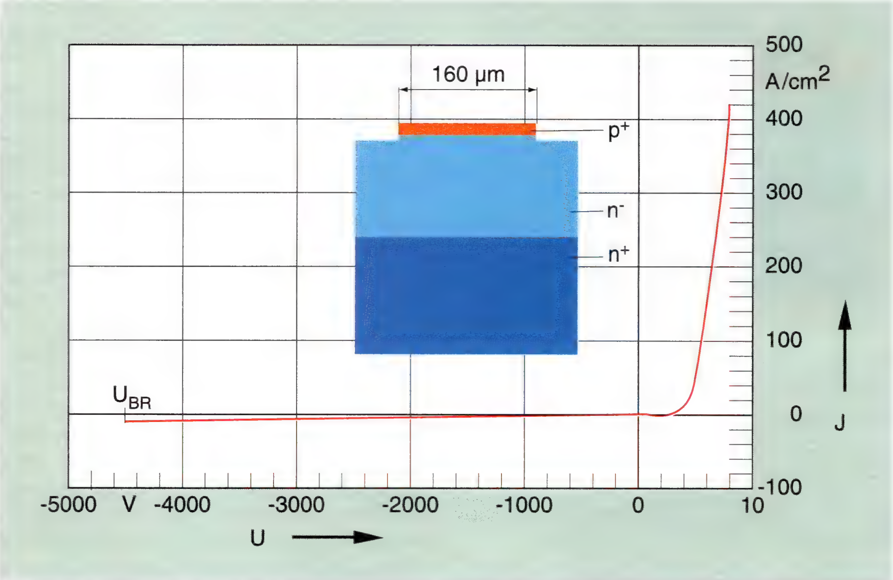

Figure 2. Current-voltage characteristic and schematic structure of a SiC test diode with a breakdown voltage of 4.5kVA world record. J = current density; U = voltage; U_{BR} = breakdown voltage; p^+ = emitter, 1.5µm, $1x10^{18}cm^{-3}$; n^- = base, 45µm, $1x10^{15}cm^{-3}$; n^+ = substrate.

Why are SiC devices still not available?

The advantages of silicon carbide power devices have been known since the 1960s. The fact that they are still unavailable today can be put down to the technological difficulties involved in their manufacture. Up until now, the main industrial use for SiC has been as an abrasive (carborundum). SiC cannot be melted under controllable pressures, instead changing directly to the gaseous state at its sublimation point of about 2500°C. The crystal therefore has to be cultivated from the gas phaseóa process which is considerably more complex than the cultivation of silicon, which melts at approximately 1400°C.

One of the main obstacles to commercial success for SiC technology is the lack of a substrate of suitable quality for the industrial-scale fabrication of power semiconductor devices. As in the case of Si, a monocrystalline substrate, often referred to as a wafer, is a prerequisite for production. One method of growing large-area SiC substrates was developed during the late 1970s. However, the substrates grown using this process, known as the modified Lely method, have been plagued by severe defects known as micropipes (*Figure 2*).

It has been shown, for example, that a single micro-pipe penetrating a high-voltage pn-junction can destroy the junction's ability to block voltage. The density of such defects has come down from thousands per square centimetre to tens per square centimetre in the last three years. In spite of this improvement, a process yield of more than a few percent is still only possible when the maximum size of the devices is limited to a few square millimetres. This restricts the maximum rated current per device to a few amperes at most. Further improvements in substrate technology are therefore necessary before SiC power devices can become commercially viable.

Silicon carbide research

One major research project, undertaken by Swiss company Asea Brown Boveri (ABB), is focused on processes for device manufacture including etching, deposition of dielectrics, oxidation, metallisation and contact formation. In contrast to Si technology, much of the SiC material for the semiconductor structure is grown by the device manufacturer rather than being provided by a substrate supplier. The reason for this is that dopingóthe controlled introduction of impurities by diffusion at high temperatureóis not practical for SiC. Instead, the dopants (impurities) are incorporated during epitaxial growth of the material. For very shallow structures (including the contact layers) ion implantation can be used, as in the case of Si.

Working together with research partners at the University of Linkoping, Sweden, and the Industrial Microelectronics Center (IMC) in Stockholm, the ABB research team has achieved some major results in the area of high-voltage SiC devices.

World record for a diode

One result of the research work is the development of an SiC diode with a breakdown voltage of 4.5kV (*Figure 2*) — a new world record. This figure improves the previously highest voltage level by more than a factor of two.

A key contribution to this result was made by the quality of the epitaxial material. The growth technology, developed at the University of Linkoping, has produced the thickest (up to 90µm) and purest (residual doping below $10^{14}/cm^3$) layers ever reported.

Until recently the minority carrier lifetime was believed by many specialists in the field to be limited to below 100ns. The 4.5kV diode mentioned above has a carrier lifetime of around 0.5µs, with even higher values observed for some samples.

Although important advances have been made, further research and development are necessary before silicon carbide devices can be produced on a commercial scale. ❐

Dr. Karl Bergman is with ABB Corporate Research in Sweden. This article first appeared in ABB Review, issue 1/96.

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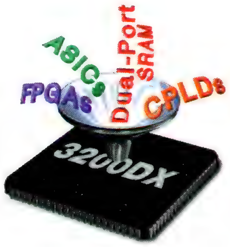

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PROGRAMMABLE LOGIC

Reconfigurable logic

Hardware speed with software flexibility

Reconfigurable logic lets you dynamically alter hardware in real time, blurring the boundary between hardware and software. *Doug Conner* explains.

If you view reconfigurable FPGAs only as static logic devices that accommodate design changes during prototyping and as occasional field upgrades, you are missing the latest frontier in digital design. The ability of infinitely reprogrammable FPGAs to dynamically redefine hardware provides performance improvements you can't afford to ignore.

Reconfigurable logic is not so much a new product as a new way of thinking. Although SRAM-based FPGAs have been available for years, new devices are offering greater performance. Depending on the device used, you can reprogram an SRAM-based FPGA from several times a second to more than a thousand times a second. Despite the device's flexibility, most designers use the reprogrammable capability as a development aid to debug and refine designs, and occasionally for field upgrades.

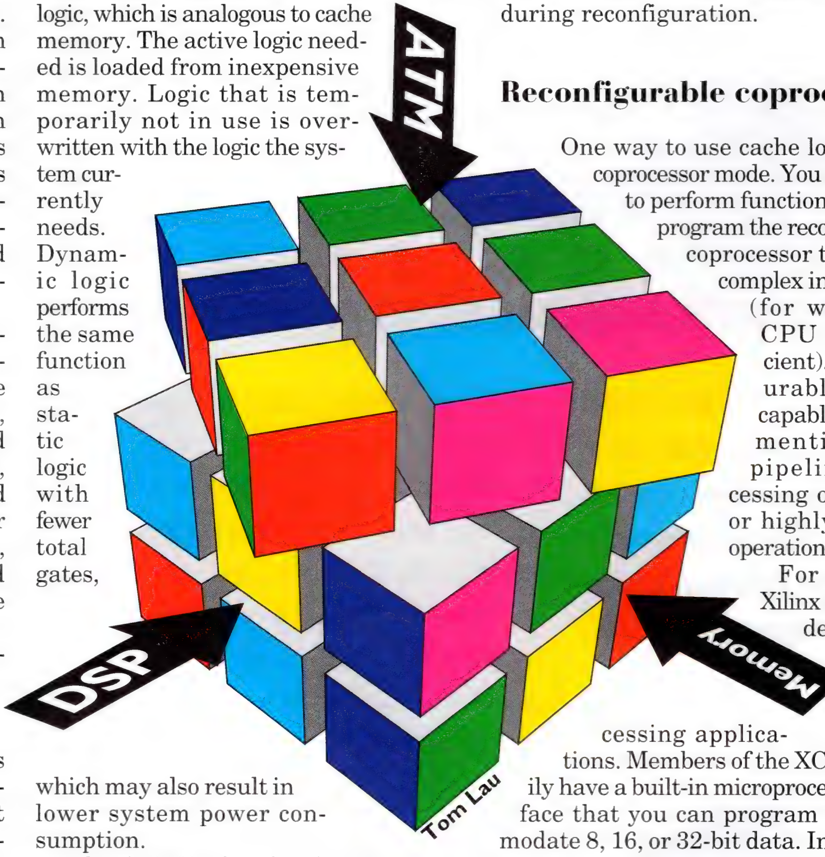
In the context of this article, reconfigurable logic refers to infinitely-reprogrammable logic devices. Reconfigurable logic differs from reprogrammable logic, which includes devices with a limited reprogramming life, such as EPROM, EEPROM, or Flash-technology-based devices. Reprogrammable devices offer many of reconfigurable logic's features, especially ease of development and field upgrades, however, they aren't suitable for dynamic logic applications.

Many designers haven't used the inherent flexibility of reconfigurable logic devices. Engineers have static-logic design education and experience. Reusing logic implies sharing resources and multiplexing functions. Two functions might use a counter at different times, provided they don't simultaneously need the counter. This practice reflects the static-logic way to view the world.

The dynamic-logic view offers more flexibility. Logic cells acting as a counter can become an arithmetic logic unit (ALU). Later, the logic cells might perform video-edge detection or act as a digital filter. You can think of reconfigurable FPGAs as uncommitted gates. You can only use a gate for one function at a time. When you no longer need that function for a period of time, you have free gates for performing other functions.

Cache logic

Atmel, a manufacturer of SRAM-based FPGAs, promotes the concept of cache logic, which is analogous to cache memory. The active logic needed is loaded from inexpensive memory. Logic that is temporarily not in use is overwritten with the logic the system currently needs. Dynamic logic performs the same function as static logic with fewer total gates, which may also result in lower system power consumption.



The AT6000 family of FPGAs from Atmel has several features that suit cache logic. Firstly, the devices are partially reconfigurable, meaning you don't need to program the entire device when you want to change a function, just the logic elements you wish to change. You can partially reprogram the device at 100ns/cell, or you can reprogram an entire 10k-gate device in 646 µs.

Secondly, even when you are reprogramming the device, the FPGA doesn't have to sit idle as the device lets you reprogram inactive areas on the FPGA as active areas continue to operate. Clocks can continue cycling, and registers don't lose their contents. Devices that only allow full reconfiguration typically can't operate during reconfiguration. In addition, these devices lose register contents during reconfiguration.

Reconfigurable coprocessing

One way to use cache logic is in a coprocessor mode. You use a CPU to perform functions, and you program the reconfigurable coprocessor to perform complex instructions (for which the CPU is inefficient). Reconfigurable logic is capable of implementing large pipelined processing operations or highly-parallel operations (or both). For example, Xilinx specifically designed its XC6200 family for coprocessing applications. Members of the XC6200 family have a built-in microprocessor interface that you can program to accommodate 8, 16, or 32-bit data. In addition, a high-speed interface provides instant read/write access to all internal registers of the FPGA.

A reconfigurable coprocessor works closely with a CPU and typically doesn't need a special operating system (OS). The next step up on the ladder of complexity is a reconfigurable computer, which can work with an extensive instruc-

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tion set and a variable architecture. The computer is limited only by the flexibility of the reconfigurable devices you use. Reconfigurable computers require a special OS to deal with the potential complexity of such a system. In return for the complexity, you can benefit from the ability to bring in complex instructions, such as for image-processing algorithms, while most often working around a small core of simple instructions.

Reconfigurable computing lets you justify a complex instruction that your design may seldom use. The complex instruction, when used, will substantially increase performance. Static logic designs pay a permanent price in silicon area for implementing complex instructions. Reconfigurable logic requires only inexpensive memory to store the instruction implementation until the instruction is needed.

Quick or slow reconfiguration

Reconfigurable logic isn't limited to processor and coprocessor-type applications. Any application in which you could benefit from having logic implement functions at different times can potentially take advantage of reconfigurable logic.

When considering the use of reconfigurable logic for an application, determine whether you will reconfigure the FPGA once per function or multiple times per function. Function refers to some application or task that interfaces either with a human or with another system on human time scales.

With human time scales, changing to a new function typically should be faster than 0.25s, but probably wouldn't increase the benefit from taking less than 10ms. For example, activating a button to change operations on a test instrument could be considered calling up a new function. Whether the function takes 1 or 100ms probably wouldn't affect the system's user.

Designs that configure logic only once per function can tolerate relatively long reprogramming times and can therefore use devices with relatively slow reprogramming cycles.

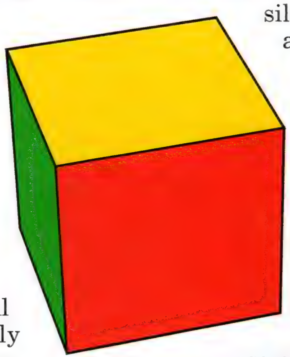
Partial and full reconfiguration

Designs that need to reprogram logic multiple times during a single function are substantially affected by long programming times. If you want to reconfigure an FPGA several hundred times a second, you need a device that reconfigures in a few milliseconds or less. Many newer devices on the market can meet these requirements. Partially reconfigurable devices, such as the Atmel AT6000 family or the Xilinx XC6200 family, not only provide short reconfiguration times, but also allow the rest of the chip to operate productively during partial reconfigurations. Although partially reconfigurable, Lucent Technologies' 2Cxx FPGA family, for example, can't operate during reconfiguration. Devices that can't operate while being reconfigured are completely unproductive during the reconfiguration time.

It is difficult to know how much time you can afford to spend reprogramming. According to Brad Hutchings, an assistant professor of electrical and computer engineering at Brigham Young University (Provo, UT, USA) and a researcher in reconfigurable systems, it varies widely. For some applications, the efficiency of the device is so high after reconfiguration that even 20% processing and 80% reconfiguring has proven useful. Other applications demand a greater percentage of processing time for efficiency. Hutchings notes that pipelined operations are a case in which full reconfiguration tends to be inefficient. A pipeline keeps the gates working, and reconfiguring interrupts the operation.

Problems with partial reconfiguration

In reconfigurable logic, the highest potential performance comes from devices that both reconfigure rapidly and offer partial reconfiguration capability to further enhance speed when making minor changes to the FPGA. This higher potential performance causes greater design complexity, however.



Designs that only use full reconfigurations typically have a more limited set of configurations that you can thoroughly test when designing the system. The use of partial reconfigurations means many different combinations of circuits are possible at any given time.

When using partial reconfigurations, you may not be able to apply the same physical location every time you implement the logic. Another group of logic functions may be using the location. To get around the problem, the logic must be relocatable.

For example, Atmel's AT6000 family offers parameterised macro generators that produce hard macros. These macros provide worst-case speed, area, and power consumption and designate the logic cells used. The uniform cell structure in the AT6000 family lets you translate the hard macro or rotate it in 90° increments without changing the macro's performance. The relocation capability lets you move the macro function to an unused group of cells anywhere on the chip.

When partially reconfiguring FPGAs, you must avoid making the transition through potentially destructive configurations in which two outputs are driving the same network. To achieve partial reconfiguration without conflicts, Atmel and Lucent Technologies provide software that designates programming sequences to get from one state to the next. Xilinx designed its XC6200 family so that two outputs can't simultaneously drive the same network.

Connecting it all

Reconfigurable logic is not just a reconfigurable sea of gates. Commercially available RAM-based FPGAs don't offer unlimited connectivity. Connectivity involves whether you can connect the logic cells the way you want, after you have found space for all logic functions. Furthermore, the connectivity issue can be split into an on-chip problem and a separate off-chip problem when using two or more reconfigurable devices.

FPGA designers have to make difficult choices between routing resources and logic. RAM-based FPGAs for a given silicon area have to trade useable logic gates for routing resources. More routing resources mean fewer useable logic gates, which, in turn, drive up the cost per gate. The end result of this trade-off is that designers of SRAM-based FPGAs try to design in adequate routing resources without leaving excess routing resources, which the designers could use more profitably as gates.

When trying to route a design that has filled up most or all of the logic cells, you may run into routing problems. In the worst case, you may find that the design simply does not route. A more likely scenario is that the design routes, but a certain number of paths are too slow. If you've used an FPGA that is too slow for your application, even when optimally routed, you have to use a faster speed-grade device. Often overworking the routing resources and forcing some networks to use long, slow routing paths cause speed problems on a few of the networks. To solve this problem, you need to use automatic, or in some cases manual, methods to force less-critical networks onto the slower paths and use the

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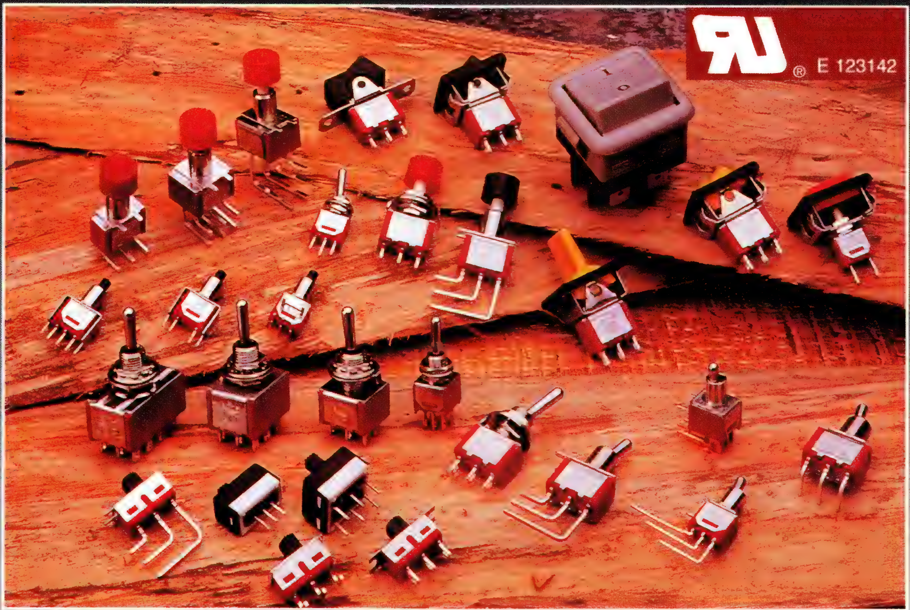

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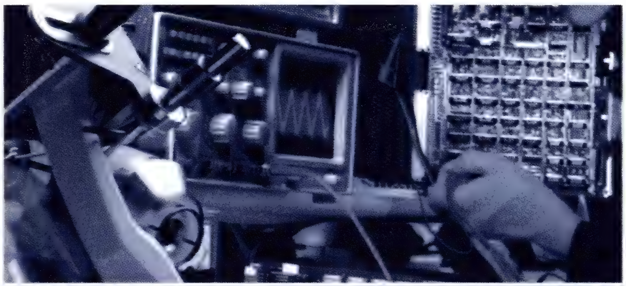

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fastest paths for the signals that need them.

Altera's Flex 8000 and 10K devices have an interconnect structure that offers more predictable timing before place and route than other devices. In fact, the company refers to its devices as complex PLDs, because the devices have a routing structure with fixed delays. This structure relates more to PLDs than to the segmented routing resources of most FPGAs. You can still run out of routing resources, but you have to go out of your way to create slow routing paths.

Accommodating architectures

If your design requires more than one FPGA, connectivity between the devices becomes an issue. Reconfigurable logic may require more than just reconnecting gates at a low level. The system may require altering the architecture of the design at a higher level. Larger designs typically place more demands on data flow and bus throughput to handle greater data rates.

For example, one application might favour linking devices in a linear pipeline arrangement, in which data is processed on one device and passed down to other devices for further processing. Another application might require highly-parallel operations in which data is distributed among many identical processing elements. In addition, one application may favour localised memory, while another may favour global memory.

Reconfigurable logic scores high marks for allowing reconfigurable architectures. Compared with static logic design, in which you have to select one type of bus and stick with it, reconfigurable logic offers a world of flexibility. You can actually use different bus schemes at different times for operations.

Reconfigurable logic does have limitations when you use multiple reconfigurable chips, however. Packaging technology limits the number of pins to a few hundred, yet these devices may have thousands of logic cells. The complete connectivity of a crosspoint-switch model is not possible on these larger designs, even if you could get enough I/O pins.

Multiple-device connectivity

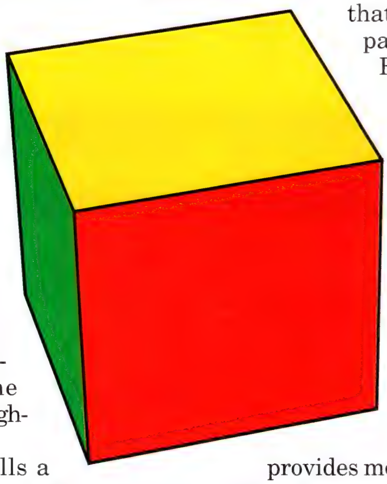
One approach to the multichip interconnect problem is to keep a large, reconfigurable bus connecting the reconfigurable logic devices. Rather than committing to one bus architecture, you can use a reconfigurable bus that allows multiple bus types. When a bus interconnect exclusively uses reconfigurable devices, you can redefine the networks on an individual basis, using various bus schemes and connecting chips at different times.

To improve connectivity, especially in large designs, you can use field-programmable interconnect devices, such as those from I-Cube. The cross point switches let you quickly reconfigure connections, providing reconfigurability in your off-chip connections consistent with the on-chip flexibility of reconfigurable logic.

The cost problem

Although connectivity can be a problem for reconfigurable logic designs, especially large ones requiring arrays of FPGAs, careful analysis and design provide workable solutions. Cost, however, is a much more troublesome problem for reconfigurable logic and FPGAs.

An FPGA requires significantly more silicon area than the same number of gates in a mask-programmed gate array. Static logic designs are difficult to justify on FPGAs except in low volumes in which NRE and manufacturing in low volume drive up the cost of mask-programmed devices to comparable levels. If you compare the device cost of FPGAs to that of mask-programmed devices, the crossover point is typically around a few thousand devices. Simple maths might lead you to believe that FPGAs are good for prototyping and for extremely-low production volumes, but the device will never be a high-volume product.



The real world tells a different story. FPGAs have proven to be an economically viable method for implementing logic for a small, but fast-growing, part of the digital market. Some of the reasons for the popularity of FPGAs include short development time, low development cost, and the ability to respond quickly to market changes whether from customer needs or from compatibility with evolving standards. Designers find that just about every design keeps evolving, so the decision as to when to cast it in silicon is a tough one to make.

The use of FPGAs in reconfigurable logic designs not only capitalises on an FPGA's strong points, but also leverages the gates to improve the economic viability of FPGAs. The usable gates of a device might be multiplied by two, 10, or more, depending on how you take advantage of reconfiguration in your design. The end result is that the cost-per-gate drops, and reconfigurable logic can compete in a wider range of applications.

Making it fast enough

The other weak point for FPGAs is speed. FPGAs can't offer clock rates quite as high as mask-programmed devices. Furthermore, interconnect problems on some designs cause clock rates to drop further. However, although there are some applications in which FPGAs are just too slow, the devices are fast enough for many applications. Nailing down specific clock speeds is difficult, because the speeds are so application-dependent. Applications that run on a single FPGA might typically run from 15 to 100MHz.

Designs spread across multiple FPGAs may suffer further speed reductions. Using reconfigurable logic at maximum speed may require you to use pipelined-design and parallel-processing techniques at lower clock speeds than you would in a mask-programmed device. For very high-speed serial data rates, you may need to perform off-chip conversion, so that you can use lower-speed parallel data paths on the FPGA.

If you think of reconfigurable logic as competing for speed with mask-programmed devices, the technique comes up a little short. Instead, consider the ability of reconfigurable logic to accelerate algorithms that would otherwise have to be performed in software. In this comparison, reconfigurable logic commonly provides more than an order-of-magnitude speed improvement.

For years the trade-off has always been that software has the best flexibility and lowest cost for executing algorithms, especially complex algorithms, and hardware offers the greatest speed, but at the greatest cost. Hardware also takes more time to design and implement. Reconfigurable logic changes the landscape. Although reconfigurable logic is more expensive than mask-programmed gate arrays on a gate-per-gate basis, the ability of reconfigurable logic to reuse the gates alters the cost equation. Designers need to re-examine what should be done in software and in hardwareóreconfigurable hardware. ❐

Doug Conner is technical editor with EDN Asia magazine. This article is reprinted with permission from EDN Asia.

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Getting to grips with FPGAs

Programmable logic for designers has previously meant using complex programmable logic devices (CPLDs) or a sea-of-gates gate array solution. The field programmable gate array (FPGA) borrows from, and fits neatly between, these two extremes.

Although the FPGA concept is relatively simple, realisation of the FPGA is complex. There are many inter-related technology and architecture issues which must be addressed to produce a successful device, ie. to result in a device that can make maximum use of the available resources to accommodate large designs, achieve the highest possible performance that the semiconductor process technology has to offer, and give the designer flexibility in, for example, pin assignments.

The global form of an FPGA is shown in *Figure 1*. The layout is a matrix of logic cells with a grid of routing channels running between the cells. I/O cells surround the array and allow access to the external pins of the device. The programmable connections are located where the vertical and horizontal routing channels cross; where the I/O of the logic cells meet the routing channels; and where the I/O cells around the periphery meet the routing channels.

In contrast with the CPLD, the FPGA usually has no programmability within the logic cells themselves. Key considerations are: the number of wires in the routing channels; the flexibility in the interconnect programmability where channels meet channels and where logic cells meet channels; and the functionality contained within the logic cell.

There are three approaches to the form of a logic cell in FPGA implementations.

- A coarse-grain logic cell. This is when the cell is as complex as in the CPLD. Unless there is programmability in the cell, this can lead to inefficient use of the available logic. The cell has only a small number of outputs. Also, many of the inputs are dedicated to flip-flop control and are not usable for other purposes if the flip-flop is not required.
- A fine-grain logic cell. The logic cell is very simple, contains no flip-flops and very minimal logic. Only one output is available. Because of its simplicity, it can have very low propagation delays and there tends to be a high cell utilisation.
- A hybrid approach between the above two extremes, with some variations that enhance the other trade-offs in the global architecture design.

The FPGA is not a gate array where gates are sacrificed for routing. In the FPGA, routing resources are limited and unused gates offer no increase in interconnect capability.

There is an optimum logic cell complexity which lies somewhere between the coarse- and fine-grained extremes. With finite routing resources available, but without fuse-related constraints, the optimal cell would look something like the cell in *Figure 2*.

This cell design is simple and symmetric, yielding small propagation delays regardless of the signal path through the cell. As the interconnect is not a factor, a large number of inputs is provided so that logic functions of many variables can be implemented. The cell also provides for the realisation of any logic function up to a given number of variables. Multiple outputs are also provided. The flip-flop may be used or the D input of the flip-flop is available as an output for combinatorial-only functions. The large number of outputs allows the cell to be split, implementing two or more simple logic functions in the same cell or sharing logic across function in the same cell.

Examine the interconnect surrounding the sea of logic cells. There are two key issues in the implementation of the programmable logic connections.

The first is size. The programmable

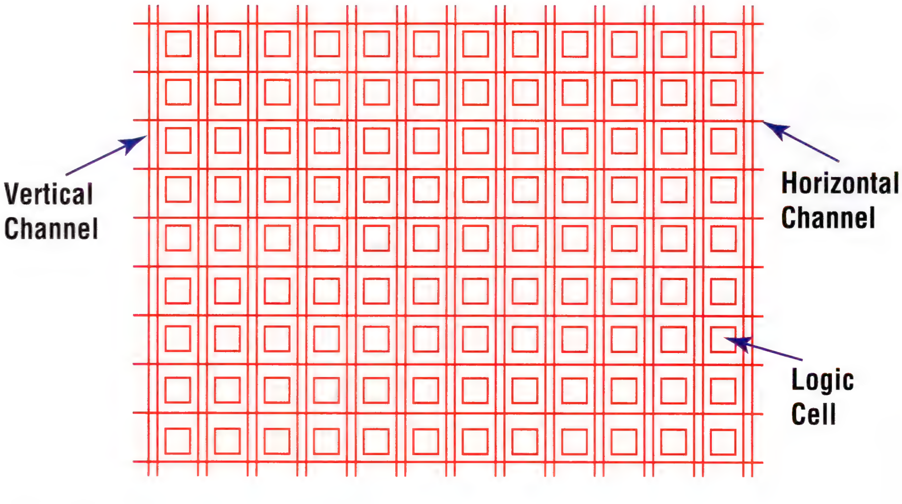
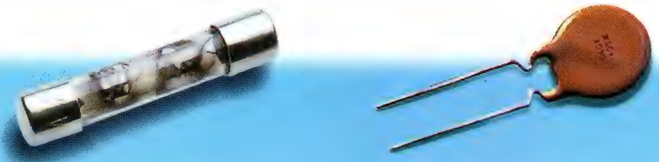


Figure 1. Global FPGA architecture.



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RAM Cell	800Ω	10fF	8ps	800ps

Table 1. Electrical characteristics of fuse technologies.

interconnect circuit may use an area which limits the number of interconnects that can be put into a given area.

The second issue is the electrical characteristics of the interconnect. The interconnect may not look like a wire to the signal that it is carrying. Resistance and capacitance of the interconnect can affect the propagation delay of the signal.

Infinite routability is not realistic. The routing channels can contain only a finite number of wires and the interconnect possibilities where wires cross or meet are not endless.

There are three classes of ways to connect two wires: RAM-based connections; large-fuse technology; and via-fuse technology.

RAM-based connectivity uses a memory cell to control the connection of one wire to another. The memory cell is far larger than the wire intersect area. What is done is to limit the connection possibilities to a small fraction of the possible signal paths and limit the number of wires in the routing channel. The result is that the FPGA becomes what is known as 'interconnect constrained'. That is, the number of wire connection possibilities is so small that the interconnect limits the realisation of functions with a given logic cell architecture.

To compensate for this, coarse-grained logic cells are usually chosen and programming internal to the logic cell may be added.

Architectures implemented with large-fuse technology tend to have the same characteristics as RAM-based connectivity except they are not as severe. Both approaches limit the number of outputs in the logic cell to only one or two. This is because increased outputs add to the number of potential connections, which places a further burden on an already stressed interconnect mechanism.

Because the number of outputs is small, simple functions will tend to waste logic resources in the interconnect-constrained, complex logic cell architectures.

Of the programmable interconnect technologies available for FPGAs, the optimum interconnect is achieved with via-fuse technology. This technology realises an antifuse in the same physical area as that used by a normal semiconductor process via which connects two layers of metal. This technology approaches the interconnect characteristics found in sea-of-gates gate arrays and almost completely eliminates programmable interconnect as a factor in FPGA wiring channel and logic cell architectures.

The electrical characteristics of the interconnect technology play a major role in the performance of the FPGA (see *Table 1*). When the connection is made, it exhibits some ON resistance in series with the logic signal path. When a connection is OFF it presents a shunt capacitance from the logic signal to ground. A single ON fuse followed by a single OFF fuse represents an RC combination in the signal path. The product of the ON resistance and the OFF capacitance of this combination is given in the time constant column of *Table 1*.

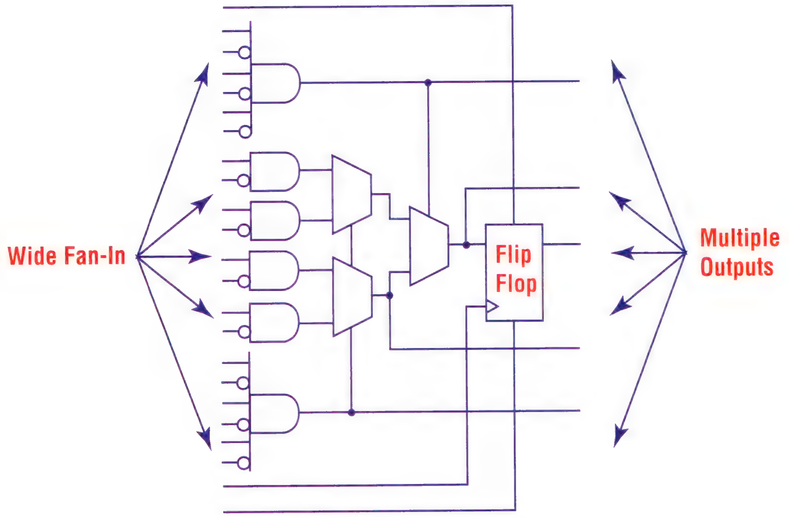

Figure 2. An optimal logic cell.

All FPGAs, by virtue of their architectures, have variable timing models. The pin-to-pin propagation delay depends on a number of logic cells cascaded together to achieve a given logic function.

There are two types of variable timing models: simple and fine-structured. In the simple variable timing model, the pin-to-pin propagation delay is chiefly dependent on the number of cascaded logic cells, signal fan-out, and the wire delay that would usually be encountered in a sea-of-gates array. The number of interconnect points in the signal path and the logic function implemented in the logic cell tend to have secondary and lesser effects on the timing. Architectures suitable for the simple timing model will have actual device delay characteristics which are independent of where the logic cell is placed in the array. In the fine-structured variable timing model, pin-to-pin propagation delay strongly depends on not only the simple model factors, but also the number of programmable interconnects in the signal path and the function implemented in the logic cell.

Table 1 includes a column which is the time constant for one series fuse connected to a gate with a capacitance of 1pF. Note that with as few as five programmable interconnects in the path from the signal source to one gate, the time constant, for some technologies, can be as large as the gate delay itself.

The technology has a profound effect on the total FPGA architecture. SRAM and large fuse based technologies cause interconnect-constrained architectures which force non-optimal logic cell architectures. In general, interconnect-constrained architected logic cells tend to be large and complex to make up for the interconnect limitations. Also, these complex logic cells tend to be wasteful of resources in certain applications. Such architectures are characterised by routing and capacity limitations and an inability to fit a design when there are pin-out constraints (the user fixes signals to particular pins). Router and fitter software may take many iterations to fit a design.

Clearly, small-size fuse technology combined with well-chosen routing channel wire complement and an optimum complexity logic cell, will yield a high-performance, small die size device. ❐

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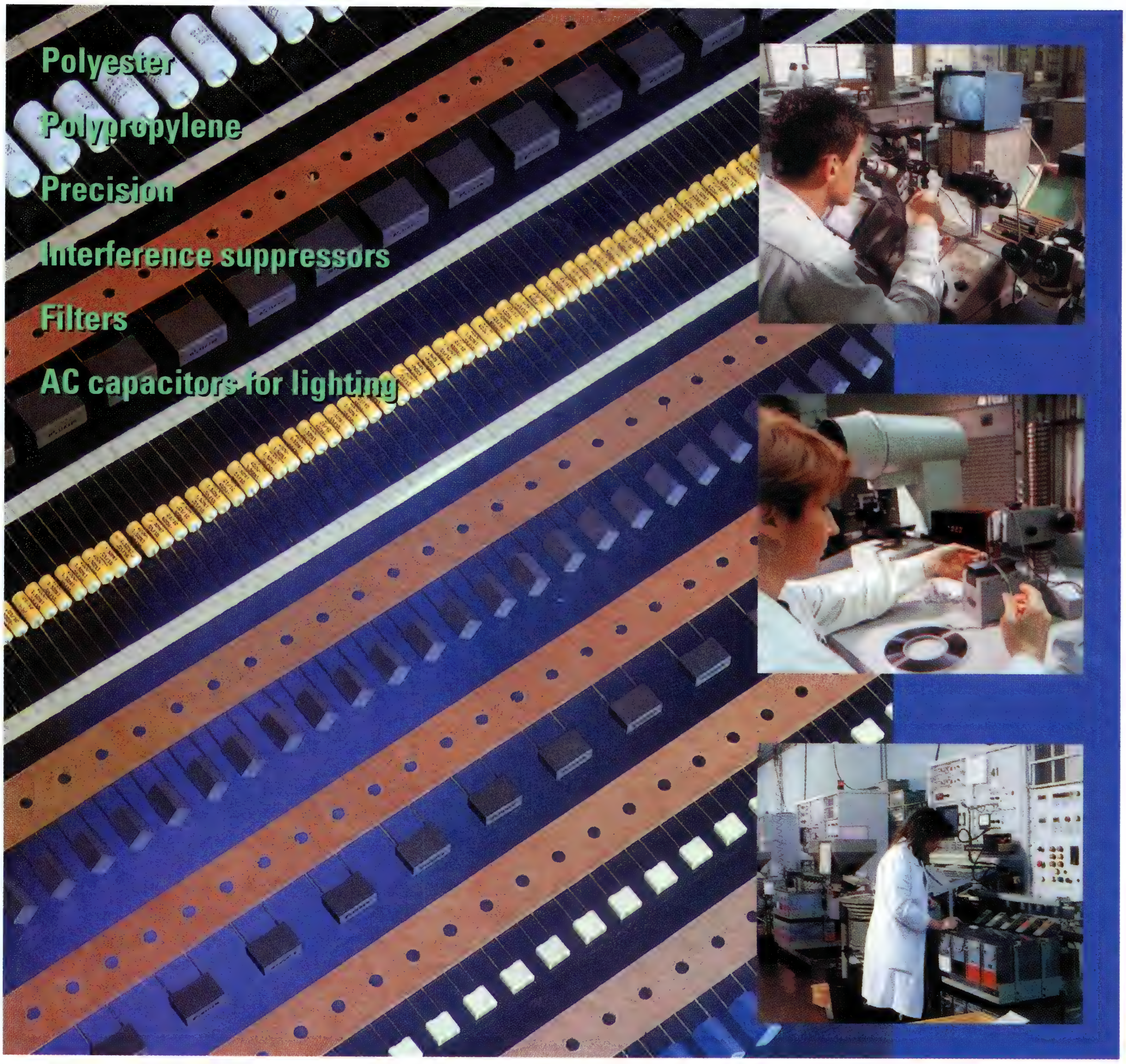

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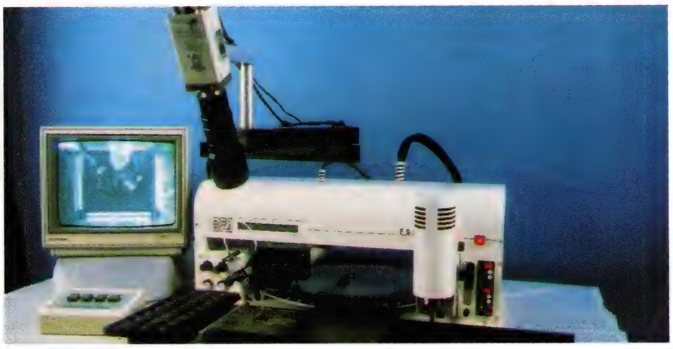

Hawker Richardson has announced the release of the new Expert 5003 system from Essemtec which provides a solution for prototyping labs, small production runs and repair centres where a precise, flexible, multifunctional system is required.

Pick and place of standard, fine-pitch, BGAs and odd components, dispensing of solder cream or adhesives, soldering and desoldering of all components by using the integrated Zevac hot air repair station and even optical inspection (optional) can be accomplished on this system.

The placement is manually done by a soft-running, air-suspended vacuum pick-and-place head with integrated illumination and Z-axis blocking capability. The head-mounted cartridge holder enables dispensing of solder cream or adhesive dot by dot with an integrated timer, or by foot pedal for line or tack dispensing. All of these tools are mounted on a precise pantograph arm with locking facilities for accurate working. Mounted on a second pantograph arm is the Zevac desoldering system which allows precise and programmable repair work for repetitive results. Hot air nozzles with integrated vacuum suction allow careful desoldering of components. Even BGAs can be repaired with this system.

The PCB is fixed on a movable X/Y fine-adjustment table which enables the use of fine-pitch components. Also available is a large variety of component feeding systems like tape and stick feeders, component trays or turntables for loose components. Optical aids like microscopes, camera and glass prism systems for parallax-free views assist the operator with delicate tasks. The Expert 5003 is also available as a semiautomatic, computer assisted pick-and-place system for error-free placements and complex prototyping. [790](334)

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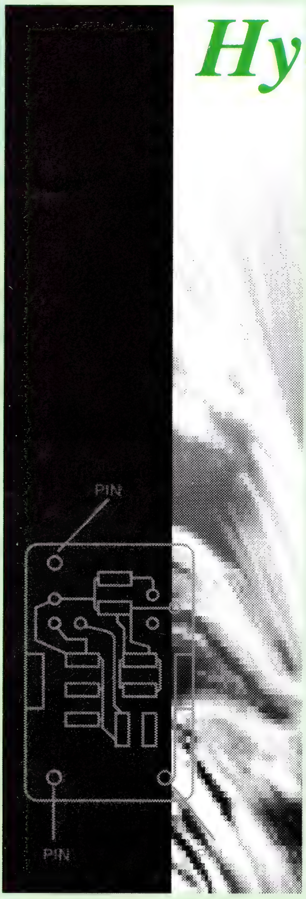

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IEEE control from notebooks

IOtech, represented by Scientific Devices, has announced the latest addition to its extensive PC/IEEE 488 controller line — the Personal488/CARD, a low-power Type II PCMCIA/IEEE 488.2 instrument controller that provides users with IEEE 488.2-compliant data transfer of up to 1Mbyte/s. The Personal488/CARD enables test engineers to interface with up to fourteen IEEE 488 instruments via the PCMCIA Type II slots found on most notebook PCs. It features hot swapping, permitting users to plug in and remove their instrument controller card without rebooting the PC. The card is compatible with other IOtech PC/IEEE 488 controllers, permitting users to seamlessly port over ISA-bus-based IEEE 488 applications to the PC/PCMCIA architecture within minutes.

The Personal488/CARD is supported by IOtech's line of software drivers for Microsoft Windows 3.x and DOS. The Personal488/CARD drivers also support user-written applications in development languages such as C, Visual Basic, Borland C++, and LabVIEW. IOtech plans to include support for Windows 95 and Windows NT in the near future.

Key hardware features include: data transfer at up to 1Mbyte/s via the IEEE 488.2 handshake protocol and automatic generation and detection of termination characters; a 2-Kbyte FIFO between the PCMCIA bus and the IEEE 488 interface; and complete Talker, Listener, and Controller functions, including the ability to monitor bus handshake lines and to detect changes on the SRQ line. [395](103)

ENTER 2820 ON CARD

DAQ with 1MS/s data transfer

National Instruments has announced a multifunction, plug-&-play ISA-compatible, 1MS/s plug-in data acquisition (DAQ) board for PC AT and EISA computers. The AT-MIO-16E-1 features the company's E Series architecture, which eliminates jumpers, switches, or potentiometers from plug-in DAQ boards. The board also transfers data directly to memory and has superior timing features. The company has also announced the CB-68 and CB-68LP connector blocks for use with all 68-pin E Series DAQ boards.

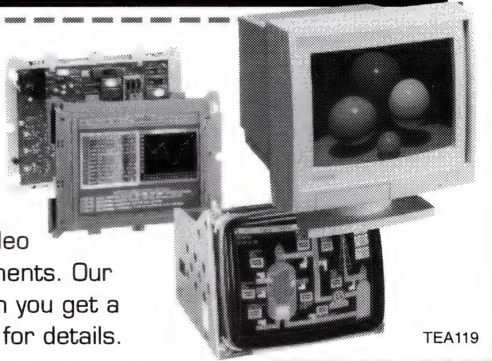
Engineers and scientists can plug the AT-MIO-16E-1 into an ISA computer, replace the computer cover, and completely configure the board through software without having to set switches or move jumpers. Through software, the user configures all aspects of the bus I/O, such as base I/O address, interrupt and DMA channels, as well as all aspects of data acquisition, such as I/O range, polarity, gain, and so on.

Users can combine the AT-MIO-16E-1 with the company's NI-DAQ driver software for DOS and Windows; LabVIEW, LabWindows, and Lab Windows/CVI application software; and signal conditioning and cabling assemblies to create high-performance laboratory automation, process monitoring and control, automotive and aerospace engineering, and electronic test applications.

The AT-MIO-16E-1 has 16 single-ended inputs, 16 pseudo-differential inputs with a shared common, or eight fully-differential inputs with 12-bit resolution; two output channels with 12-bit resolution; eight TTL digital I/O lines that can sink 24mA on each line; and two 24-bit counter/timer channels.

The board has a 1MS/s sampling rate and transfers the data using DMA, interrupts, or programmed I/O. It features on-board gain of 1, 2, 5, 10, 20, 50, or 100, and input ranges of +10V, 0 to 10V, and +5 V. The input polarity, gain, and mode (differential or single-ended) are fully software selectable on a per-channel basis. The AT-MIO-16E-1 has full hardware and digital trigger capability. It has an 8,192-word input first-in-first-out (FIFO) buffer, a 2,048 word output FIFO buffer, and dual-channel DMA to guarantee high throughput rates for input, output, and general-purpose counters. [388](9180)

ENTER 2821 ON CARD



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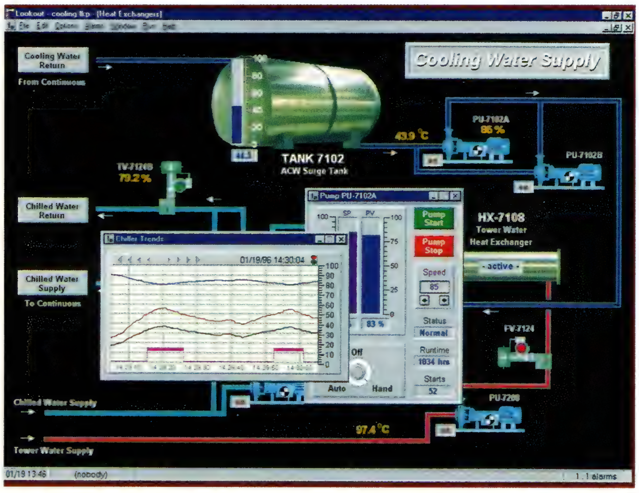
32-bit industrial automation software



National Instruments has announced native 32-bit Windows 95 and Windows NT versions of its Lookout industrial automation software. Lookout, formerly available from Georgetown Systems as a 16-bit application for Windows 3.x, Windows 95, and Windows NT-based PCs, now gives users a 32-bit, object-oriented, event-driven environment for building a wide variety of applications ranging from simple human-machine interface (HMI) to large, supervisory control and data acquisition (SCADA) applications.

With Windows 95, Lookout users are better protected from other applications — each application has its own thread to the PC processor. Lookout, which features sophisticated I/O drivers and the powerful CITADEL historical database, has been used successfully in a wide variety of industrial applications, including chemical, petrochemical, batch processing, food processing, pharmaceutical, water and wastewater treatment, transportation, plastics/glass/metals, energy management, and manufacturing. [384](9180)

ENTER 2822 ON CARD

Free embedded development system software

A free Single Step Starter Kit, an advanced debugging development kit for Microsoft Windows 3.1, Windows NT and Windows 95 platforms, is available from Alfa-Tek.

Single Step is the industry's first fully-integrated solution for developing and debugging embedded, real-time applications under both Windows and Unix. The Single Step Starter Kit (Version.01) represents a completely re-engineered tool set that includes new C and C++ compiler, assembler and instruction-set simulator for the various PowerPC and Motorola 68000 family microprocessors. The Single Step Starter Kit is only limited by the amount and complexity of code along with the amount of memory that can be simulated.

According to the distributor, the Single Step development kit permits developers to write small amounts of C/C++ and assembly code, then interactively simulate it in order to experiment with high-quality code for embedded applications. Users can test drive the Starter Kit at no cost and prove that software and hardware design can occur simultaneously, resulting in a significantly shorter design cycle. Once the project is in full swing, developers can easily upgrade their Starter Kits to one of a wide range of debuggers and simulators offered as part of the complete Single Step product line. [384](696)

ENTER 2823 ON CARD

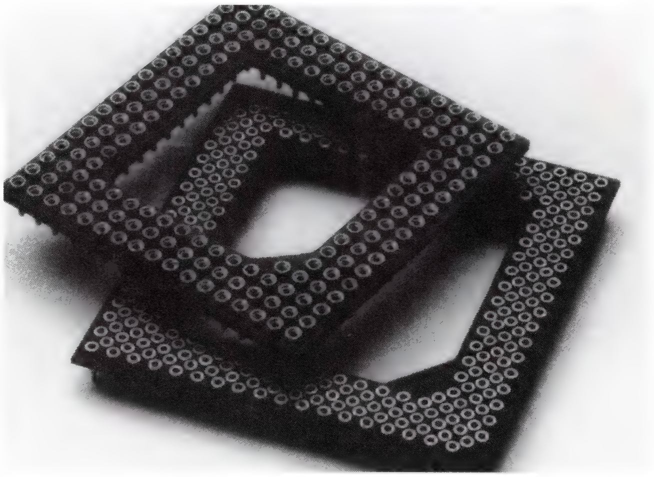
150MHz digital scope

Nilsen Technologies has announced the METRIX OX2000, 150MHz programmable SCPI digital oscilloscope with LabVIEW/LabWindows CVI driver capability, allowing operation from user-designed software

The four-channel OX2000 has a bandwidth of 1500MHz, a single-shot sampling rate of 200MS/s and up to 50GS/s for repetitive waveforms. The instrument has internal memory of 40KB, allowing the storage of four waveforms of 10,000 points each. A built-in PCMCIA capability extends the storage capacity by 1MB per card. The OX2000 is fully-programmable with SCPI (Standard Commands for Programmable Instruments). Standard ports are RS232, IEEE 488.2 and Centronics, enabling screen output to be sent to a printer, plotter or computer file. The OX2000 has a dual time base and extended trigger functions including trigger after preset count, trigger after delay, and TV. Acquisition modes include direct sampling, roll (for slow measurements), envelope, min/max and glitch capture. [1270](910)

ENTER 2824 ON CARD

Surface-mount PGA sockets



The Augat GSM series (Glass Epoxy Surface Mounted) LIF PGA sockets offer advantages over solder-tail sockets.

Using the surface-mounted PGA socket as opposed to a solder-tail socket allows the designer to use the solder-tail side of the PCB to mount additional surface-mount components, thus maximising board space. It also eliminates a costly wave soldering process by using the same vapour-phase or IR soldering process used to solder all other surface-mounted components.

The GSM series is an original Augat (Patented) design first introduced in 1987. It incorporates "Butt Style" terminals with the company' s exclusive floating feature which assures compliancy to the printed circuit board surface. The socket includes the Augat SUPERLIF low insertion force 1.3oz contacts, which are rated at 3A and have a contact resistance of 10mΩ. The contact-to-contact capacitance is 1.0pF. High temperature insulators allow the sockets to be soldered with vapour phase and infrared reflow soldering processes.

The GSM Series can be ordered to suit a wide a range of popular pin-grid-array footprints and Augat can also supply a wide variety of application-specific PGA and IPGA sockets.

Typical applications for the GSM Series of PGA sockets are in low profile notebook PCs and portable terminals. [794](3948)

ENTER 2825 ON CARD

Rack-mount chassis with redundant power supply

Interworld Electronics has announced the 7520-34H range of rack-mount industrial PCs from Industrial Computer Source. The 7520 range of chassis comes in a number of options: ISA backplane with 20 AT slots or split backplane options of 2x10 or 4x5; EISA backplane with 15 EISA and 5 ISA slots; and PCI backplane with 18 slots — 15 ISA, 2 PCI and one dedicated slot for the PCI bus PCI card. In addition to this the units come with the option of a single 300Wuniversal ac power supply, a 350W, 48Vdc power supply; or a redundant dual 300W ac power supply.

The 7520 range provides mounting for up to four half-height drives, with all drives shock mounted and mounted behind a lockable front door. Four 45CFM cooling fans are mounted behind a filtered door unit to ensure the system is positively pressurised.

The front panel contains an on/off indicator, system power supply status LEDs, fan status and overtemperature LEDs, and disk drive activity LEDs, while the on/off switch, reset button and keyboard connector are located behind the lockable front door. In addition, a keyboard connector is available at the rear of the chassis.

For the split backplane options, separate reset switches and keyboard connectors are available at the rear of the chassis for each backplane section.

The redundant power supply chassis option includes two 300W ac power supplies in an N+1 configuration. The two supplies share the current load during normal operation. In the event of one supply failing, the other supply can carry the full 300W load. A front panel indicator indicates normal operation of each supply and an audible alarm sounds in the event of a failure. The defective supply can then be hot swapped with a spare module without interrupting system operation. [1250](4933)

ENTER 2826 ON CARD

In-circuit emulator and software tools

Zatek has available MPLAB — Microchip's Integrated Development Environment (IDE) — which gives designers the flexibility to edit, compile and emulate from a single user interface. This interface can make a developer productive quickly and can reduce overall development time.

Microchip's Picmaster development systems have also been updated. Picmaster offers design engineers power, flexibility and rapid design turn-around, and with a range of real-time in-circuit emulation capabilities under Windows, the Picmaster systems provide a universal PIC16/17 microcontroller development environment.

Picmaster-16/17 emulator systems are designed to support all PIC16C5X, PIC16CXX and PIC17CXX microcontrollers through the use of interchangeable target probes. This greatly reduces both cost of ownership and the learning curve.

The systems include an emulator control pod, a PC host-interface card, a target-specific emulator probe; MPLAB IDE software, and a PRO MATE programmer with comprehensive documentation. [690](8897)

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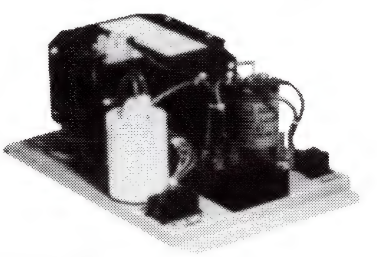

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Calibration kit for Metrix ASYC II series DMMs

The Metrix SX-ASYC IIC Calibration Kit, available from Nilsen Technologies, permits calibration of ASYC II series DMMs without opening the instrument. An interchangeable faceplate, which is part of the kit, is clipped in place of the DMM's faceplate and calibration proceeds via an infra-red path between the calibration faceplate and a receiver, which is an integral part of the ASYC II DMM. The Calibration Kit is supplied with the faceplate which has a 25/9-pin adaptor suitable for the RS232 ports of PCs, and software including a LabWindows Driver and complete calibration software.

The ASYC II series DMMs are high-resolution, 50,000-count TRMS instruments with a bandwidth of 100kHz. They are suitable for ac, dc, and ac+dc measurements, and measure voltage, current, capacitance and frequency (to 500kHz) as well as pulse counts and percentage duty cycle. Positive and negative pulse width measurements are also provided. Other features include storage of last reading, peak capture and relative reading modes. [1270](910)

ENTER 2830 ON CARD

AEE is moving

Australian Electronics Engineering is moving offices. From August 24, please contact *AEE* at: **Level 9, Chatswood Plaza, 1-5 Railway Street, Chatswood NSW 2068,** tel **(02) 9372 5222**, fax **(02) 9934 7377**.

Custom clock oscillators

Hy-Q International has established a new production line dedicated to manufacturing competitively priced custom frequency clock oscillators.

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The oscillators will be manufactured by Hy-Q International's United Kingdom facility where design and production are quality assured to ISO9001 standard. With these facilities Hy-Q Australia will deliver products within 10 to 15 working days.

These custom frequency oscillators complement the extensive range of standard oscillators Hy-Q Australia has available in stock. [620](934)

ENTER 2832 ON CARD

UHF wireless

Amber Technology has added the Beyer U600 series wireless microphone system to its range of UHF wireless systems. The U600 series is a true synthesised system with the capability of 64 channels within one UHF TV channel and up to 15 channels simultaneously. Initial releases have a beltpack transmitter while a handheld transmitter is due for release. The U600 series is suitable for professional applications in broadcast, OB, location sound, live sound reinforcement and theatre.

A feature of the series is its channel grip capability, which locks the receiver exclusively to its associated transmitter. This function excludes any other signal or interference which does not carry the unique ident code, giving the series better stability even when operating in crowded reception environments. Employing switchable frequencies, the system is useful for travelling and allows greater channel flexibility.

The TS600 UHF beltpack transmitter is lightweight, rugged and permits discreet placement in clothing. It may be switched through 16 frequencies within a single UHF TV channel and operates in the UHF band between 794 to 822MHz and 854 to 862MHz. Constructed from aluminium, the TS 600 features a 4-pin Lemo connector for the microphone input. The TS 600 measures 80 x 54 x 20mm and weighs only 157 grams. [100](2173)

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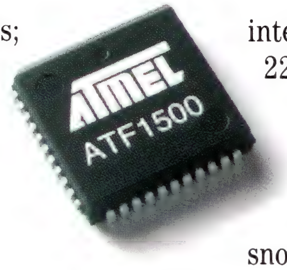

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ENTER 7839 ON CARD

Touch-screen panel PC

The Workmate HYLAS PC111T is a flat screen PC workstation with integral infra-red touchscreen, available from Automation & Process Control. The touchscreen-sensitive area extends beyond the screen, providing an area for 'touchkeys'. The user can configure these like a keyboard. The touchscreen driver software automatically converts the touch to the appropriate keystrokes. Users can insert their own legends on or behind the glass screen.

The Workmate HYLAS is fitted with a flat 10.4" colour TFT LCD display. It comes with a single board processor with PC104 expansion slots, or a three-slot passive backplane for half length ISA cards. The unit is fully sealed (IP65) and rated to 50°C. [387](6484)

ENTER 2834 ON CARD

Industrial chassis

Interworld Electronics has available a range of industrial chassis from Industrial Computer Source in the US. The 7415-23V and 7408-23V provide similar features for passive backplane (15 AT slots) and motherboard systems (baby AT or full size AT motherboards) respectively. Standard 19in rack mount and desk-top models are available for both the passive backplane and motherboard mount systems.

The chassis are built for use in harsh commercial or industrial environments where vibration, temperature and airborne contaminants present a hazard to standard office grade computer equipment. The chassis contain a 106CFM front mounted, filtered air intake fan for pressurising the inside of the chassis. A second 106CFM fan is available for more extreme environments. This positive pressurisation prevents airborne contaminants from entering the chassis and the areas surrounding the floppy disk drives where normal office systems draw their air input.

The front panel of the chassis provides a power switch, power-on indicator, system reset switch, a standard AT-style DIN keyboard connector (with an additional keyboard connector at the rear of the chassis), and a fixed disk-drive access light.

The power supply is a 250W 115/230Vac switch selected with its own cooling fan for direct cooling of its components and reliable operation in warm to hot ambient temperatures. DC power supplies can also be used — 12Vdc, 75W; 24Vdc, 120W; or a +48Vdc (–48Vdc) 145W power supply can replace the 115/230Vac power supply.

For passive backplane systems, the 7415-23V chassis includes a 15 slot, four-layer, low capacitance backplane incorporating all 16-bit ATslots connectors and the exclusive Bus Power check circuitry from ICS. [380](4933)

ENTER 2835 ON CARD

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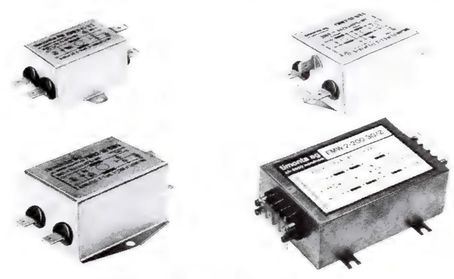

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DESIGN TIP #35

PCMCIA dc-dc converter

Products such as PCMCIA cards require circuitry to be extremely low in height, so component choice is critical. This design takes advantage of recent advances in dc-dc converter design and very low-profile power inductor technology.

Not all PCMCIA card slots provide the assortment of voltages required for all memory cards. Because the missing voltages are most often the higher programming ones, a switching regulator is the ideal choice for an on-card solution to the problem.

Fitting a switching regulator inside a PCMCIA Type I card is no small task. Every IC-based switching regulator must have at least a diode, inductor coil, 2 capacitors and a switcher chip. Special technology has evolved for each of these components. The circuit described in *Figure 1* is a solution for PCMCIA Type I dc-dc converters.

Voltages will be converted from 3.3V to 5V and 3.3V/5V to 12V. The task of identifying suitable components is a critical part of the design process. The design of a converter centres around the switching regulator and the power inductor.

Simple, self-contained chips suitable for converting a 3.3V, 5V or 12V output have been available for some time. The TSSOP package, introduced several years ago, meets the height requirement of Type I cards. The other components of a switching regulator have lagged behind. Even now, there is no single power Schottky rectifier available for Type I use.

Switching regulator

The integrated circuit used for this design is an LT1106. It is specifically designed for on-card generation of the 5V or 12V programming supply necessary for Flash memory. An on-card switcher is included in cards where compatibility is a key feature, as the card can function even when the host product does not support the full complement of supply voltages. The LT1106 implements a boost topology and can generate 12V at 60mA (Vpp) from a 3.3V or 5V socket supply. A programming pin on the LT1106 allows the designer to select either 12V or 5V regulated output to match the particular memory type used in the card.

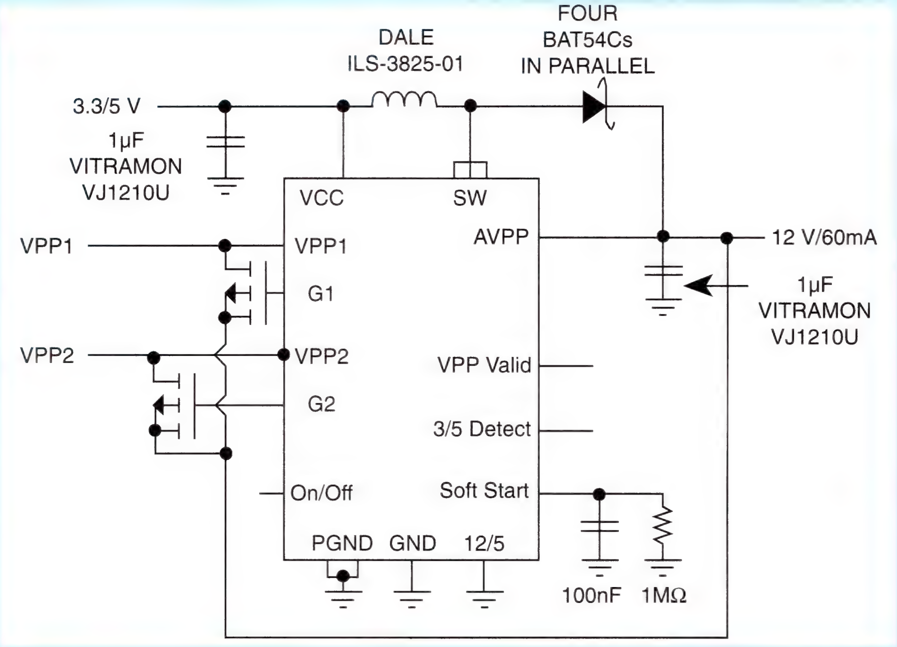

Figure 1. DC-DC converter circuit for Type I PCMCIA cards

The boost regulator output can be ramped by use of a soft-start circuit included on the LT1106. There are several benefits to soft-starting, including controlled peak input current, predictable output rise time, and elimination of output overshoot.

Another key feature is the LT1106's ability to bypass the boost converter in sockets where Vpp is present. Gate drive is supplied to 2 P-channel MOSFETs to switch Vpp straight through to the card's Vpp lines, and the boost converter is shut down. This feature conserves power, prevents the boost converter from back-feeding the host's Vpp lines, and makes the card universal in application.

The LT1106 operates at an equivalent frequency of 500kHz, using current-commutated, constant ON time hysteretic control. Typical switch ON time is 1.8µs, with a peak switch current limit of 0.6A. Ideal inductor values fall in the range of 10 to 15µH, and 1µF capacitors are acceptable as input and output filters.

Owing to the fast switching of the converter, it is necessary to take special precautions when designing the printed circuit board. Current rise and fall times of 20ns in the switch translate to volts of spiking if trace lengths between the switch, output capacitor and Schottky diode are not short. Since all of the components are surface mount and generally small, a compact layout is easy to achieve. Nevertheless, the components must be held in close proximity to minimise stray effects.

Circuit board designers must not be seduced by the TSSOP lead pitch of 25mils. There is a temptation to use narrow printed circuit board traces to connect components. It must be kept in mind that high currents (0.6A) flow in the switcher, so short, wide traces must be used. Note that critical paths, such as power ground and Vsw are brought out through multiple pins to help reduce inductive and resistive effects in the bond wires, leads and PCB traces.

Continued on page 62 ☛

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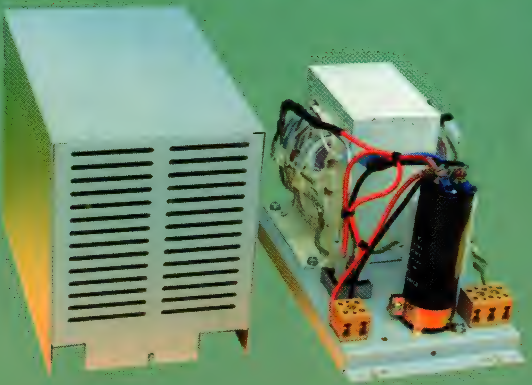

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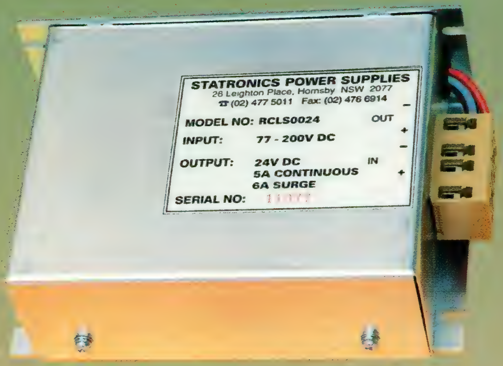

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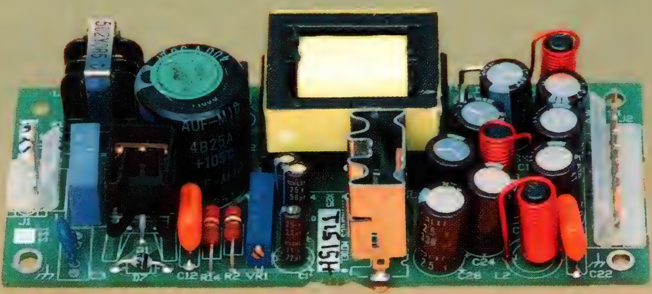

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DESIGN TIP #36

Power from a three-wire serial port

This handy circuit derives 5V power from the TX line of a three-wire RS-232C port.

Many peripherals running from a computer's serial port need a low-current 5V supply to power the device's on-board circuitry. While a separate power supply can be incorporated using a plug-pack adaptor, the circuit described below can supply enough power for low-power circuits directly from the RS-232 Transmit (TX) line.

The circuit in *Figure 1* produces a semi-regulated 5V output from an RS-232C port. Unlike a PC-mouse supply or comparable circuits that rely on the DTR and RTS modem-control signals, this circuit operates with a three-wire port — GND, RS, and TX — and obtains power only from the TX line. Except at high duty cycles, the TX line (RCV-232 on the circuit side) remains operational while supplying power. The output current of approximately 8mA is sufficient for CMOS ΩCs and other low-power circuits.

Figure 1

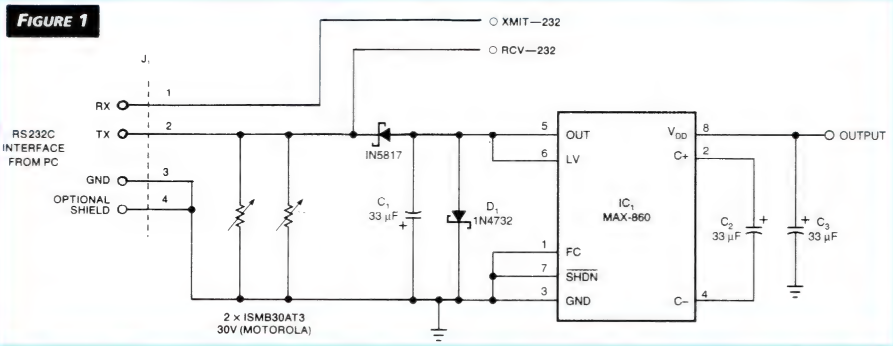


Figure 1. This circuit derives a 5V supply from the TX line of an RS-232 serial port.

IC_1 is a switched-capacitor, charge-pump voltage converter that can either invert or double an input voltage. The connections in *Figure 1* provide a doubler configuration in which the normal input-voltage polarity is reversed. A positive input voltage normally connects between the GND and OUT pins. This circuit connects a negative input between OUT and GND, however IC_1 then doubles the negative input voltage in the positive direction, producing a positive output at V_{DD} equal to {V_{IN}}.

Zener diode D_1 acts as a shunt regulator that semi-regulates V_{IN} to -4.7V. The large values of C_1, C_2, and C_3 support the output voltage during worst-case (all-zero) patterns of transmission. At 9600 baud, for example, an all-zeros transmission causes an output droop of about 0.2V. For lower baud rates you should substitute a proportionally higher value for C_1. ❒

This article was submitted by Veltek

Continued from page 60

To limit switch loss and prevent inductor saturation, the switch current is limited to 600mA. Under full load, several switch cycles are likely to occur in succession. The 600mA peak switch current limit prematurely resets the 500kHz oscillator, forcing the frequency to rise above that value. For example, in the circuit shown, the switching frequency at the threshold of continuity (125mA load current) is approximately 600kHz.

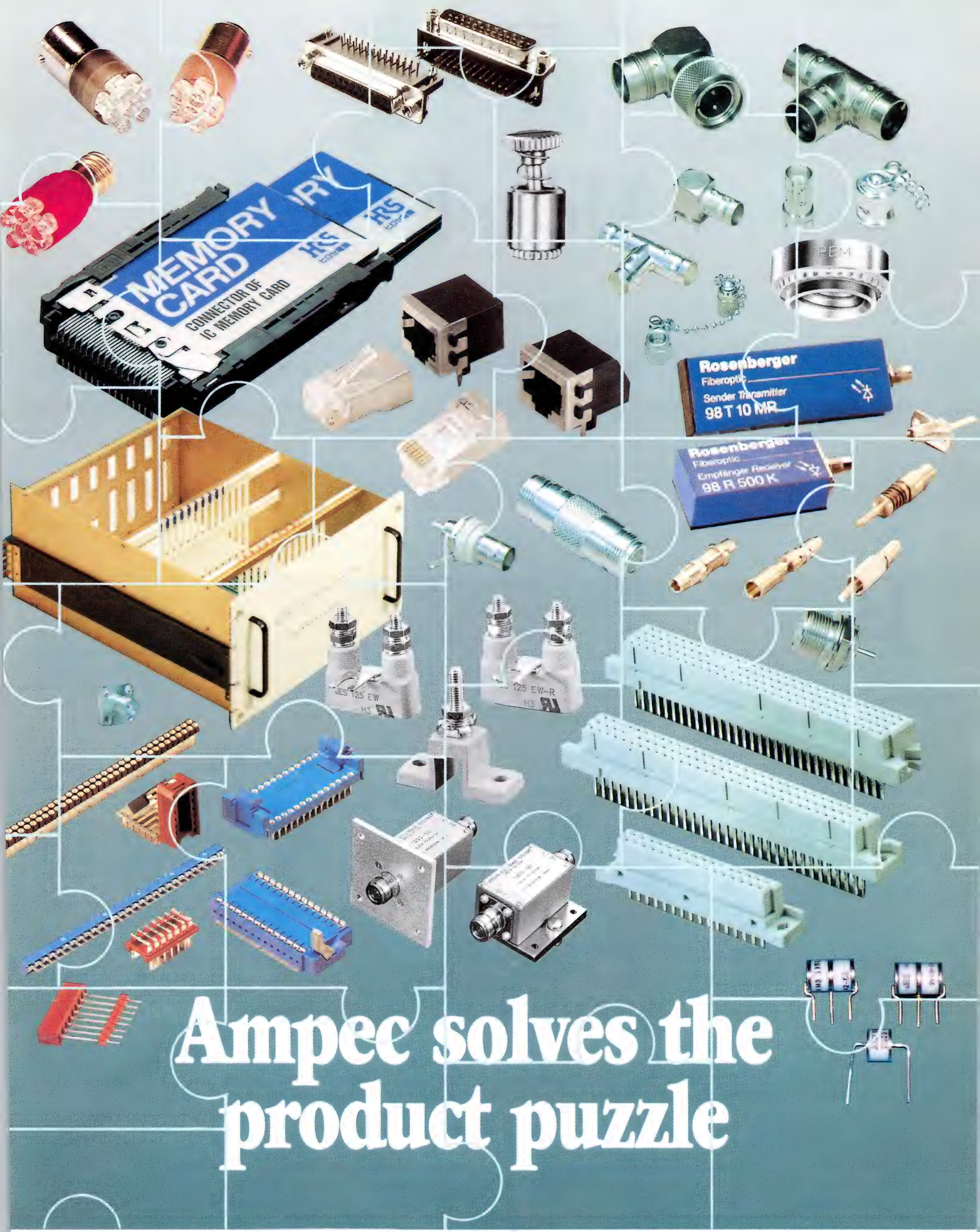
The MOSFETs used are Zetex BSS84 devices (10Ω), and are supplied in an SOT-23 package with a maximum height of 0.043" (1.1 mm), meeting the Type I specification.

Power inductors

By far the most challenging component for miniaturisation is the inductor. The Dale ILS-3825 power inductor used in this design is constructed with multi layer technology as opposed to discrete material technology. The size of the ILS-3825 inductor is a fraction of the planar solutions — as little as 1/4 the footprint.

The ILS-3825 inductor has an unexpected group of electrical parameters. The Q values are much higher than those found in other types of power inductors. This is particularly true for the higher frequencies that are required for small, medium power applications. The energy storage capability is also quite high relative to the size of the inductor and the effective core shape of the inductor. The effective core shape resembles a nearly closed magnetic path similar to a pot-core inductor. This core type provides efficient energy transfer in a dc-dc converter application. Pot core shape inductors also emit very low levels of EMI radiation when compared to such core shapes as bobbins. ❒

This article adapted from a Dale Electronics application note. Dale is represented in Australia by Vishay.



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LAST WORD

Mike Kerr

Linking nations

Mike Kerr was present at the birth of the optical-fibre submarine cable industry in Australia, when the TASMAN 2 undersea link to New Zealand was started. Now, as general manager of Alcatel TCC, he plays a major role in developing the industry in Australia.

by Rob Irwin

Born in 1955, Mike grew up in Sydney's northern suburbs of Willoughby and Beecroft. After finishing high school, he was taken on as a trainee by AWA and studied electrical engineering part time at the then Institute of Technology, now the University of Technology, Sydney. "I was taken on as a trainee engineer when I left High School with AWA," explained Mike. "So I did my course over six years part-time and then stayed on [with AWA] for about four to five years after graduating."

Mike believes AWA provided fertile ground for young engineers in those days. "At that stage it had a pretty good training programme for its cadet engineers and it put you through just about every department that existed," remembers Mike. "I was working at North Ryde, which was the engineering products division, and it was a little bit like an engineers' sandpit at the time in the sense that they were into everything. It's unbelievable looking back on it now. [They produced] everything from audio consoles to quite advanced data equipment, and right through to high power radio transmitters — everything you could possibly imagine. They did it all."

In hindsight, Mike admits that AWA lacked a good business focus, but commented that "for a trainee engineer it was just brilliant because you could move around from one department to another, spending anywhere from 3-9 months learning about what they did. By the time you graduated you really did have a pretty broad knowledge of what electronic engineering was all about."

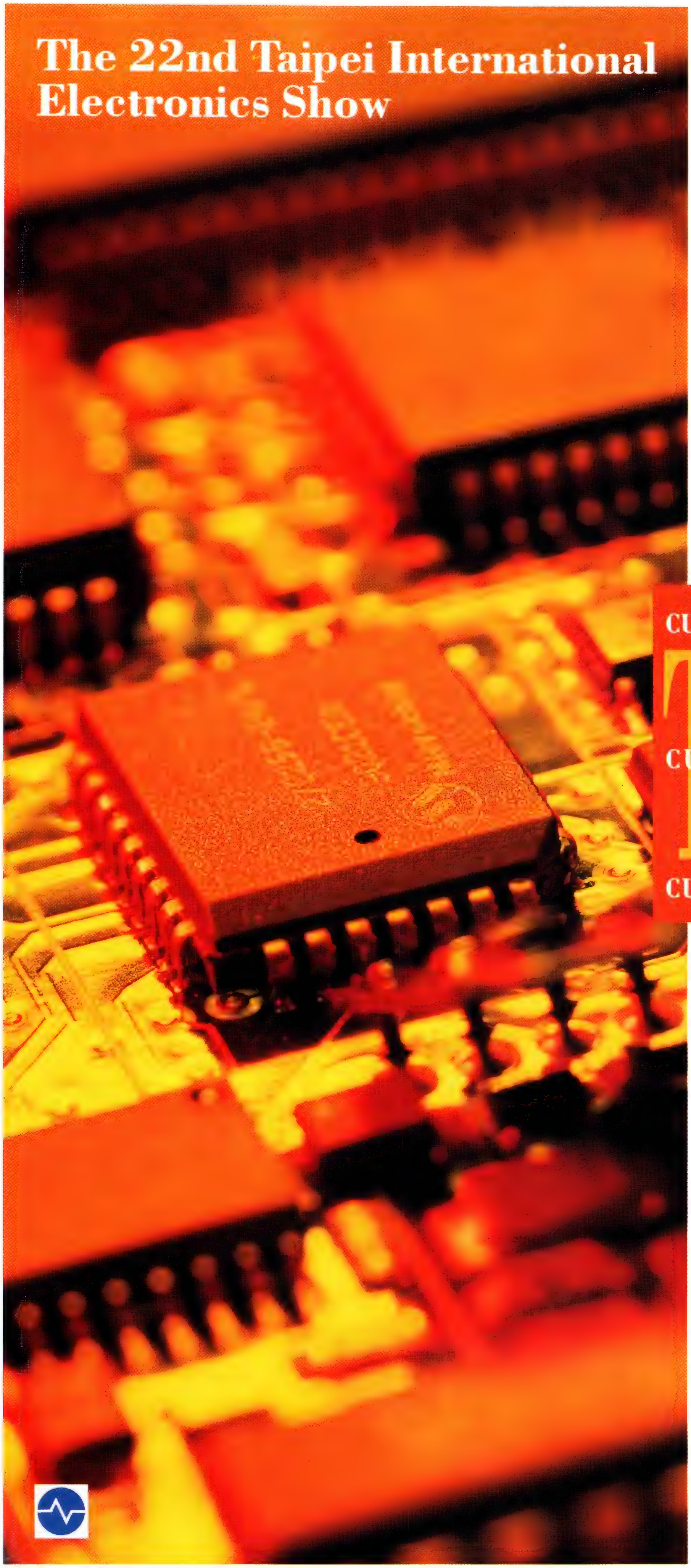
Mike obtained his engineering degree in 1978 and stayed with AWA for another five years, working in the data products area. "At that stage Telecom was a very big user of Honeywell mainframes, and in an effort to boost the local content they looked at sourcing Honeywell-compatible terminals in Australia, which was the sort of thing that AWA did."

Mike left AWA in 1984 and joined what was then Standard Telephones and Cables (STC) as a telecommunications marketing engineer. He was primarily involved in the data side of the business, but in 1987 the company commenced a project which was to change Mike's focus and lay the foundations for his future career path. "Around 1987, STC, as Alcatel still was then, was in the process of bidding for the TASMAN 2 submarine cable system between Australia and New Zealand. I got involved with that from a marketing point of view and have been involved with submarine cables ever since."

According to Mike the TASMAN 2 contract, which called for a fibre-optic link between Australia and New Zealand, brought about tremendous changes in the company and prompted the birth of a new industry in Australia. "It was a fascinating period and an unbelievable activity to be involved in. It was one of those incredible challenges that Alcatel seems to be able to rise and respond to," commented Mike.

"The activity for TASMAN 2 happened just before Alcatel was formed. We (STC) started the bidding process, working with a company that had been somewhat of a traditional partner for us in the submarine cable industry. That was STC, our namesake if you like, in the UK. We had been involved with them on two previous systems back in the early 80s — ANZCAN and A-I-S. ANZCAN is a very big cable that goes from Australia to North America and A-I-S goes from Western Australia to Indonesia and Singapore."

In January 1987, STC Australia's parent company ITT merged its telecommunications businesses with those of another giant CGE to form Alcatel. The result was a turnaround in the direction of the TASMAN 2 tender, because STC in the UK was not part of the merger.



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"We'd been working for something like six months on the TASMAN 2 tender with STC in the UK; and in January [1987] all of a sudden we became part of Alcatel and we found out that there was a submarine cable company in Alcatel called Submarcom, which we knew almost nothing about. [Submarcom was] a traditional rival in some ways to the submarine cable part of STC in the UK." After the merger, Mike remembers there was "an interesting period of about three months where we were trying to see if there was some way the three companies could put together a joint bid — STC UK, Submarcom and STC."

This wasn't to happen, however, and STC in Australia, now part of Alcatel, found itself ultimately bidding in opposition to its former collaborator, STC UK. "It very quickly became apparent that it just wasn't going to be possible to put together a joint bid. The sceptics would have said it was doomed to failure from the start to get rivals such as Submarcom and STC in the UK to work together. Ultimately STC UK pulled out. They decided that they'd be better off putting in a bid on their own.

"They advised us something like six weeks before the tender was due to close that they wished to submit a bid of their own. This presented STC Australia with an enormous challenge." With only six weeks left to get a bid in, the combined forces of STC Australia and Alcatel in Europe put together a bold proposal. "Looking back now I think it was an amazing act of business faith that in that short period of time a group such as Alcatel was able to basically agree to putting in a bid which involved making a $120 million investment in Australia, if it was successful."

The Alcatel bid was essentially to establish a whole new submarine cable industry in Australia and to invest $100 million in setting up the infrastructure to manufacture optical-fibre submarine cable here.

Alcatel was awarded the contract in December 1987. A new company, Alcatel TCC, was formed and Mike took on the role of marketing manager.

"It was a pretty challenging and exciting prospect in December 1987 to suddenly realise that we'd been awarded this contract. At that stage there was just a bit of registering the company's name. We had to get on with establishing a whole new industry here in Australia, one which involved not only recruiting staff and building factories, but transferring special technology, which Australia at that stage knew nothing about."

Alcatel TCC started building a factory to house its cable-making activities in Sydney's Port Botany in May 1988 and began recruiting the necessary personnel. "We had to rapidly recruit the core group of people that we wanted to form the heart of the company, and many of those were immediately dispatched off to Europe to start working with the various companies in France who were going to be assisting us with the transfer of technology."

While Mike's focus in the initial years was the TASMAN 2 project, he also recognised the need to build up a good marketing team to look at ongoing business. The TASMAN 2 project was obviously a big kick start for the industry in Australia, but Mike recognised the importance of raising the company's profile on the world stage. "One of the key elements in this industry is credibility. You have to have a track record of successfully installing cable systems to really be able to get out there and compete against the other companies, because the other companies are some of the biggest companies in the world.

"It is a very small industry and we were incredibly lucky looking back on it that the then OTC and Telecom New Zealand had the courage and the faith in local industry to encourage, through the TASMAN 2 tender, local involvement. That gave Alcatel's cable business the opportunity to establish an industrial presence in the Asia-Pacific."

The success of the TASMAN 2 project is recorded history now, but Mike remembers that there were doubts at the start of the project. "I'm sure there were many people in the industry who were expecting it to be a failure, because it had never been done before. No one had ever transferred lock stock and barrel the technology required for submarine cable systems to another country. It was an enormous undertaking, it really was."

Mike was appointed to the position of assistant general manager of Alcatel TCC in 1991, the same year installation of the TASMAN 2 cable link was completed. Just over a year later he took over as general manager.

Since taking the helm of the company, Mike has honed his appreciation of the courage involved in Alcatel's decision to develop an optical-fibre submarine cable industry in Australia. "We had to spend $120 million to build the factory and then had all the costs of building the TASMAN 2 cable system — all on the basis of a single $120 million order. So needless to say, we were making pretty substantial losses in the first years. But that's the sort of thing that large companies such as Alcatel are prepared to do if they feel the future of the business justifies it, and they obviously did. But clearly there's an act of faith there that it is going to be successful.

"Looking back on it now, even though I've been involved from day one, I find it an incredibly courageous decision to take. It was something maybe I didn't think too much about at the time, but now that I'm responsible on a day-to-day basis for the numbers, I can really feel what it must have taken to make that sort of decision."

That "courageous decision" has proven to be a financially sound one, with Alcatel TCC following on from TASMAN 2 with major contracts to supply cable for the PacRimEast cable link between New Zealand and Hawaii, and PacRimWest from Sydney to Guam. More recently, Alcatel TCC has been contracted to build the JASURAUS high-speed fibre network between Australia and Indonesia, which will connect onto the Asia Pacific Cable Network (APCN).

Alcatel TCC's involvement in such projects has given the company the "credibility" Mike sees as crucial to success in the industry. With several major contracts successfully completed, Mike looks proudly on the company's history. "It's remarkable to be able to say that in the six years we have been manufacturing cable, we have secured something like a billion dollars' worth of orders. That's a pretty staggering achievement.

"From a personal point of view, to have been involved from day one of the bidding process through to the winning of the tender, and then see the whole industry built up from scratch to being a billion-dollar success story is a unique experience. It's the sort of thing that happens once in your lifetime."

While Alcatel TCC's successes to date are impressive, Mike feels the future could be even rosier. With bandwidth demands skyrocketing, optical-fibre submarine cable links have become the solution of choice for many communications companies.

Australia, through Alcatel, is well placed to be a major player in the development of these infrastructures. But according to Mike, some people don't recognise the importance of this to the country as a whole. "They see a large company like Alcatel and make the easy criticisms like 'they're a multinational, what good do they bring to countries like Australia?' But the simple fact is, if it wasn't for a company like Alcatel being prepared to take the risk in the first place, make the investment and transfer the technology to Australia, Australia wouldn't have a submarine cable industry. And not only that, we wouldn't have all of the suppliers in the background which are now able to supply materials to the level of quality and reliability we demand. There wouldn't even be a market for them to participate in."

Mike is single, enjoys long-distance running, squash and tennis, and lives in the Sydney suburb of Epping. ❐

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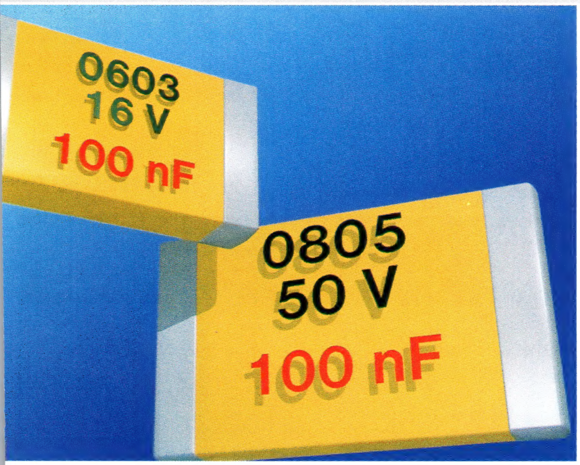


Philips has extended the capacitance range of its 0603 and 0805 class (X7R) ceramic multilayer chip capacitors.

Ceramic multilayer chip capacitor range extended

The capacitance range of Philips' 16 V 0603 series and 50 V 0805 CMC series (X7R dielectric) have both been extended to 100 nF. The capacitance of the 16 V 0603 series now extends from 10 to 100 nF and that of the 50 V 0805 series from 0.18 to 100 nF.

The 100 nF 0805 capacitor was formerly available only with a 25 V specification. The new 50 V version can be regarded as the replacement of the well known 100 nF 1206 50 V version. Philips' introduction of 100 nF CMCs in size 0603, moreover, represents an important milestone in CMC development since capacitances of its value were not formerly available in such small sizes.

Both the 0603 and 0805 ranges are available with nickel-tin terminations. Their small dimensions plus their excellent performance characteristics and high reliability make them ideal for applications where space and weight are limited, for example portable communications, laptop computers and pagers.

Philips adds new capacitors to it's extensive range

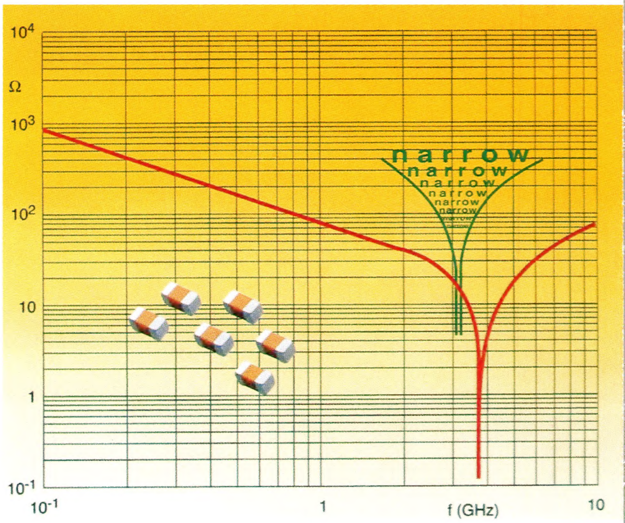
Narrow-tolerance 0603 ceramic multilayer capacitors for high-frequency communications

Philips has developed a range of narrow-tolerance NP0 ceramic multilayer capacitors for precise impedance matching in HF communications equipment.

At very-high (e.g. microwave) frequencies, the value of capacitors becomes ever more critical. Production spreads in, for example, transceiver front ends can lead to significant deviations in transceiver characteristics. For these circuits, precise capacitance is as critical as good high-frequency characteristics, low dissipation factor and low drift. Formerly, narrow-tolerance (±0.1 pF) capacitors were several times as expensive as their ±0.25 pF counterparts which meant that, to avoid using these more expensive components, system manufacturers often had to trim their circuits to get consistent performance characteristics.

Recent advances by Philips in, for example, screen printing and electrode manufacture has led to the development of a new narrow-tolerance CMC class I series (NP0 dielectric) offering excellent price/performance ratio. These advances have also resulted in better control of the series resonance of the CMCs.

The new series offers tolerances of just ±0.1 pF for capacitances below 2.7 pF. Tolerances of ±0.05 pF are also available on special request. The capacitors moreover offer the important benefits of high reliability and high stability with regard to voltage and temperature variations.



Supplied in tape on reel in size 0603, the capacitors are available with NiSn or AgPd terminations, suitable for reflow or wave soldering. Rated voltage is 50 V.

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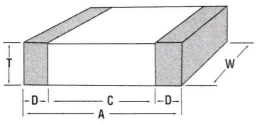
	N	N	N	N	N	N	N	N	N	N	N
0.10				🟨							
0.12				🟨							
0.15				🟨							
0.18				🟨	🟦		🟨		🟨		
0.22				🟨	🟦	🟦	🟨	🟨	🟨		
0.27				🟨	🟦	🟦	🟨	🟨	🟨		
0.33				🟨	🟦	🟦	🟨	🟨	🟨		
0.39				🟨	🟦	🟦	🟨	🟨	🟨		
0.47				🟨	🟦	🟦	🟨	🟨	🟨		🟨
0.56				🟨	🟦	🟦	🟨	🟨	🟨		🟨
0.68				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
0.82				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
1.0				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
1.2				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
1.5				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
1.8				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
2.2				🟨	🟦	🟦	🟨	🟨	🟨	🟨	🟨
2.7				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
3.3				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
3.9				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
4.7				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
5.6				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
6.8				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
8.2				🟨	🟦	🟦	🟨	🟨	🟨	🟨	
10				🟨	🟦	🟦	🟨	🟨		🟨	
12	🟨			🟨	🟦	🟦	🟨	🟨		🟨	
15	🟨				🟦	🟦	🟨	🟨		🟨	
18	🟨				🟦	🟦	🟨	🟨		🟨	
22	🟨				🟦	🟦	🟨	🟨		🟨	
27		🟨			🟦	🟦	🟨	🟨			
33		🟨			🟦	🟦		🟨			
39		🟨			🟦	🟦		🟨			
47		🟨			🟦	🟦		🟨			
56		🟨			🟨	🟦		🟨			
68		🟨	🟨		🟨	🟦		🟨			
82		🟨	🟨			🟦		🟨			
100		🟨	🟨			🟦		🟨			
120		🟨	🟨			🟨					
150			🟨			🟨					
180			🟨			🟨					
220			🟨			🟨					
270			🟨								
330			🟨								
390			🟨								
470			🟨								

A=AgPd terminations
N=NiSn terminations

DIMENSIONS IN MM



size code	A	W	T_{min}	T_{max}*	D_{min}	D_{max}	C_{min}
0603	1.6 ± 0.10	0.80 ± 0.10	0.70	0.90	0.25	0.65	0.40
0805	2.0 ± 0.10	1.25 ± 0.10	0.51	1.35	0.25	0.75	0.55
1206	3.2 ± 0.20	1.60 ± 0.15	0.51	1.75	0.25	0.75	1.40
1210	3.2 ± 0.15	2.50 ± 0.15	0.51	1.75	0.25	0.75	1.40
1812	4.5 ± 0.20	3.20 ± 0.20	0.51	1.75	0.25	0.75	2.20
2220	5.7 ± 0.20	5.00 ± 0.20	0.51	1.75	0.25	0.75	2.90

* Detailed information on thickness can be found in the Philips Passive Components Product Selection Guide

STOCK POLICY:

🟦 Manufacturing quantities held in Australian stock
🟨 Short run quantities available from Australian stock

Please consult the Philips International
Product Selection Guide for the complete
range of chip capacitors.

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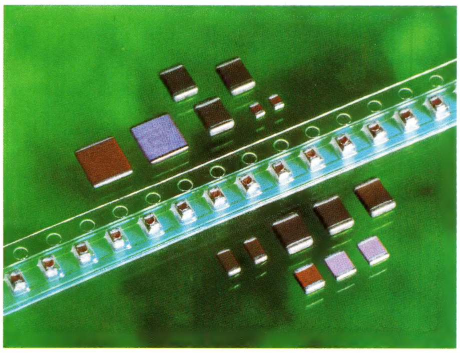
Australian Preferred Range

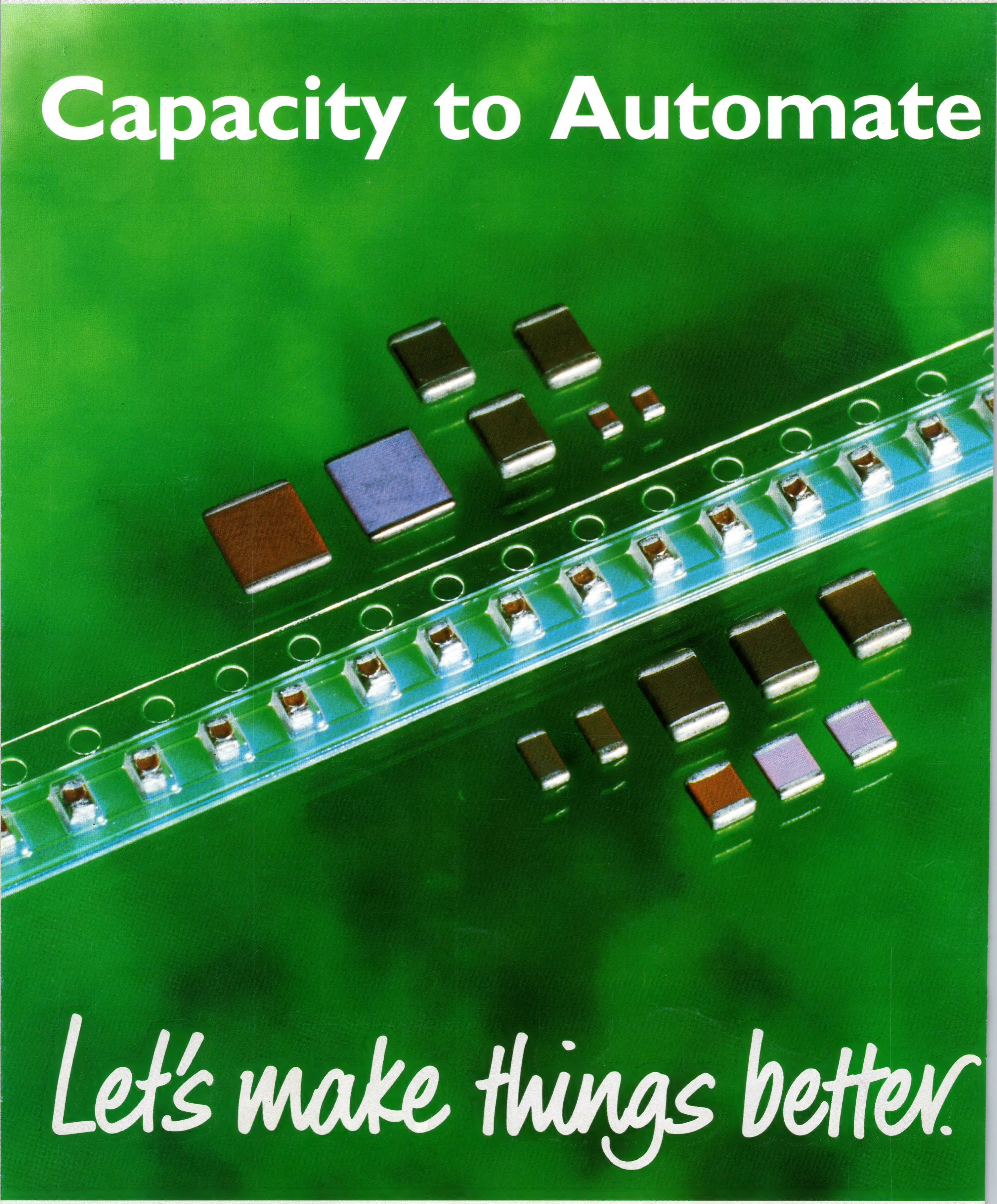
	NPO 50V					NPO 100V		NPO 200V		NPO 50V
C(pf)	0603	0805	0805	1206	1206	0805	1206	0805	1206	1206
	N	A	N	A	N	N	N	N	N	N
0.47	🟨		🟨		🟨					
E12	🟨		🟨		🟨					
3.9	🟨		🟨		🟨					
4.7	🟨		🟨		🟨					
5.6	🟨		🟨		🟨					
6.8	🟨		🟨		🟨					
8.2	🟨		🟨		🟨					
10	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
12	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
15	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
18	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
22	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
27	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
33	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
39	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
47	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
56	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
68	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
82	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
100	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
120	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
150	🟨		🟦		🟦	🟨	🟨	🟨	🟨	🟨
180	🟨		🟦		🟦	🟨	🟨		🟨	🟨
220	🟨		🟦		🟦	🟨	🟨		🟨	🟨
270	🟨		🟦		🟦	🟨	🟨		🟨	
330	🟨		🟦		🟦	🟨	🟨		🟨	
390	🟨		🟦		🟦	🟨	🟨		🟨	
470	🟨		🟦		🟦	🟨	🟨		🟨	
560	🟨		🟦		🟦	🟨	🟨		🟨	
680	🟨		🟦		🟦		🟨			
820	🟨		🟦		🟦		🟨			
1000	🟨		🟦		🟦		🟨			
1200		🟨			🟦		🟨			
1500		🟨			🟦		🟨			
1800		🟨			🟦		🟨			
2200		🟨			🟦					
2700		🟨			🟦					
3300		🟨			🟦					
3900		🟨		🟨						
4700		🟨		🟨						
5600				🟨						
6800				🟨						
8200				🟨						
10 000				🟨						

DIELECTRIC CHARACTERISTICS

Dielectric: EIA/IEC, CECC		NPO/CG	X7R/2RI
Capacitance range		0.47 pF to 100 nF	100 pF to 3.9 µF
Tolerance	C<10pF C≥10pF	±0.1pF, ±0.25 pF, ±0.5pF ±1%, 2%, 5%, 10%	±5%, 10%, 20%
Climatic category		55/125/56	55/125/56
Temp. coeff. Temperature characteristic	C<10pF C≥10pF	0 ± 150 ppm/K 0 ± 30 ppm/K	± 15%
Rated voltage		50 V, 100 V, 200 V, 500 V	16V, 25V, 50V, 100V, 200V, 500V
Tanδ	C<10pF C≥10pF	$\leq 10 (\frac{3}{C} + 0.7) \times 10^{-4}$, max 30×10^{-4} ≤ 10 x 10	< 250×10^{-4}
Insulation resistance		> 100 GΩ	> 100 GΩ or R x C>1000s
Measuring voltage Measuring freq.	C≤1000pF C>1000pF	1 Vrms 1 MHz 1 kHz	1 Vrms 1 kHz 1 kHz



- All families have high capacitance values available on indent in larger case sizes 1210, 1812 and 2220 selectively
- For additional information, please consult the Philips International Product Selection Guide or data handbook PA06.
- Microwave rated 50 V NPO chip capacitors in 0602, 0805, 1206 available on indent



SELECTION GUIDE INSIDE

Philips Components supports the complete range of ceramic chip capacitors. From the smallest size to the largest, high or low voltage specifications, in bulk or reel. Philips have the products to suit your needs

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